Vol. 3.] 1930. [No. 1.

AGRICULTURAL JOURNAL

Issued by the
Department of Agriculture, Fiji.

PRICE, ONE SHILLING.

DEPARTMENT OF AGRICULTURE.

STAFF LIST.

ADMINISTRATIVE DIVISION—

Superintendent of Agriculture	A. C. Barnes, F.I.C., B.Sc., A.M.I.Ch.E.
Assistant Superintendent of Agriculture	James Kermack.
Chief Clerk	A. B. Ackland.
Clerks	J. S. Rennie, E. J. Hart, N. G. J. McNally, Miss D Armstrong.

VETERINARY DIVISION—

Senior Veterinary Officer	C. R. Turbet, B.V.Sc.
Veterinary Officer	H. M. Stuchbery, B.V.Sc.
Stock Inspector (Temporary)	T. R. Colebrook.

RESEARCH AND LABORATORIES DIVISION—

Government Entomologist	H. W. Simmonds, F.E.S.
Government Chemist	W. J. Blackie, M.Sc.
Government Mycologist	J. G. C. Campbell, B.Sc.

PRODUCE INSPECTION DIVISION—

Inspector of Produce	James Kermack.
Assistant Inspector of Produce	L. B. Greaves (Acting).

FIELD EXPERIMENT DIVISION—

Cotton Specialist	R. R. Anson.
Cotton Inspector	B. L. Field, A.M.I.E. (India).
Assistant Agricultural Officer	B. F. Hooper.
Field Assistants	H. V. Petley, C. M. Dass.
Ginnery Assistant	J. T. Mackie.

FIELD INSPECTION—

Inspectors of Plantations	J. White, S. E. H. Coster.
Do. (Temporary)	N. MacDonald, W. Pocock, N. W. Faddy, L. H. Dietrich.

GOVERNMENT RICE MILL—

Manager	J. P. Tarby.
Assistant	E. Dowell.

TAILEVU DAIRY FACTORY—

Manager	H. R. Leaning.

COCONUT COMMITTEE STAFF—

Entomologists	R. W. Paine, B.A. (Cantab.) T. H. C. Taylor, B.Sc. (Lond.)
Agronomist	H. R. Surridge, A.R.C.Sc. (I).
Field Inspectors	R. I. C. MacGregor, C. A. Stokes, J. Beveridge.

COCONUT COMMITTEE—

Superintendent of Agriculture (Chairman).
Secretary for Native Affairs.
Sir Maynard Hedstrom.
E. Duncan, Esq.
Major Willoughby Tottenham.

Secretary, A. B. Ackland.

FIJI LIVESTOCK RECORD ASSOCIATION—

President—Superintendent of Agricul[illegible]
Directors—Superintendent of Ag[illegible]
Senior Veterinar[illegible]
R. Craig, Esq.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 3.] FIRST QUARTER, 1930.

EDITORIAL.

A SUCCESSFUL Agricultural Conference, presided over by His Excellency the Governor, was held in the Supreme Court House, Suva, on January 17th and 18th, 1930. The Conference was originally planned as a purely Departmental function for the Staff, but, at the express wish of His Excellency the Governor, its sphere was extended and the proceedings were made public. There was a representative gathering at the opening of the proceedings and keen interest was taken by all who attended, as is evidenced by the discussions on the papers read, which are published in this number of the *Journal*. The occasion of the Conference afforded members of the Department, many of whom are situated in distant parts of the Group, an opportunity to meet and discuss various matters of interest not recorded in the proceedings. The Superintendent of Agriculture and Mrs. Barnes were "At Home" to members of the staff and their wives on the afternoon of January 17th, when an enjoyable time was spent. It has been decided to make the Conference an annual function of a public nature and to invite contributions from members of the agricultural and commercial community, as well as from members of the Department. It is probable that the occasion of the Fiji Agricultural Show will be a convenient time at which to hold the Annual Conference. Open discussion of agricultural problems cannot but be beneficial, and a closer co-operation between the Agricultural Department and the community can best be effected by the holding of periodical conventions of this nature.

THE DECEMBER STORM.

It is unfortunate to have to record that a serious cyclonic storm visited the Group early in December and caused considerable damage to standing crops and property in certain districts. In Vitilevu the storm was accompanied by exceptionally heavy rainfall, which caused a serious flood of the Rewa river and resulted in considerable damage. The adverse effects of the storm were reflected in the banana shipments for the months of December and January. It will be a few months before the quantity of fruit available for export becomes normal. It is comforting to note, however, that serious as the damage was in many areas, investigation proved it not to be so great as was originally estimated. The field staff of the Agricultural Department has made surveys of the storm damage in various districts and a number of officers took prompt measures in regard to relief work. Mr. Anson, Cotton Specialist, and Mr. Field, Cotton Inspector, are particularly deserving of praise in this connection. They have been officially thanked for their services on storm relief work by His Excellency the Governor.

LIVE STOCK RECORD ASSOCIATION.

The quarterly meeting of the Board of Directors of this Association and the annual general meeting were held on December 17th. The Minutes

of the meetings will be found in this number of the *Journal*. All interested in the stock industry are urged to become members of this Association which has for its object the improvement of cattle, horses and other stock in Fiji.

TAILEVU DAIRY SCHEME.

His Excellency the Governor, attended by Sub-Inspector W. J. G. Holland, A.D.C., and accompanied by the Superintendent of Agriculture and the Secretary of the Tailevu Dairy Scheme, visited the Tailevu district on Thursday January 30th, returning to Suva on 1st February. The party landed at Lodoni and after a ceremonial welcome by the native community, walked along the track of the proposed Lodoni–Korovou road to the end of the completed portion of the road near Burerua. They proceeded by car to Korovou and afterwards drove over the northern section of the Korovou–Nadururuloulou road. The following day His Excellency inspected the school and the dairy factory, afterwards presiding over the annual general meeting of the suppliers of butter-fat to the Tailevu Dairy Factory. After an informal lunch kindly provided by the settlers and their wives His Excellency and party inspected each homestead on the Government Tailevu Dairy Scheme. In the evening His Excellency was "At Home" to settlers, their wives and families at the house of Mr. W. T. Gatward. The keen interest taken by His Excellency the Governor in all affairs connected with the Settlement cannot but be attended by excellent results. There can be no doubt that whatever the past history of the Settlement may be, it is now firmly established and can look forward to a prosperous future. The matter of communications evidenced by the construction of the main road from Nadururuloulou and the excellent system of local roads now being pushed in the direction of Lodoni by the Tailevu Road Board will remove the feeling of isolation hitherto experienced by the residents and inspire them to increased exertion. They were assured at the last meeting of Legislative Council of a sympathetic consideration by Government and that assurance has been exemplified by His Excellency's visit.

STAFF NOTES.

Mr. C. R. Turbet, B.V.Sc., returned from leave and assumed duty as Chief Veterinary Officer on the 11th January, 1930.

Mr. H. M. Stuchbery, B.V.Sc., proceeded on three months' leave on 18th January, 1930.

Mr. T. H. C. Taylor, B.Sc., sailed for Java on coconut investigation work by the "Niagara" on 29th November, 1929. He is due to return by the repatriation vessel "Sutlej" scheduled to arrive in Suva on February, 28th, 1930.

Mr. G. A. Wishart, Assistant Inspector of Produce, resigned his appointment with effect from the 20th November, 1929.

Mr. L. B. Greaves, Temporary Inspector of Plantations, has been gazetted Acting Assistant Inspector of Produce, temporary, with effect from the 20th November, 1929.

Mr. B. F. Hooper has been appointed Assistant Agricultural Officer, temporary, and has assumed charge of the Nasinu and Navuso Experimental Stations. Mr. Hooper took up duty on the 1st January, 1930.

Mr. T. R. Colebrook was gazetted Stock Inspector for work in the Northern and Western districts of Vitilevu on the 21st October, 1929.

Mr. J. C. Flemons joined the Department as an Agricultural Pupil on the 10th February, 1930.

AGRICULTURAL CONFERENCE.

THE following are the proceedings of an Agricultural Conference held at the Supreme Court House, Suva, under the presidency of His Excellency the Governor, Sir A. W. Murchison Fletcher, Kt., C.M.G., C.B.E., on January 17th and 18th, 1930:—

His Excellency the Governor.—Mr. Barnes, ladies and gentlemen, it gives me great pleasure to open this Conference this morning and I am particularly pleased to see such a good muster in view of the short notice that the Conference would be open to the public. I attach the greatest importance to a meeting of this kind. We have to live in this Colony by agriculture and it is necessary that we should study by all means in our power the methods by which we can improve the agriculture which we carry on. Here we have the need of expert advice, and we want co-ordination, we want the assistance and co-operation of the community which is actually engaged in planting. What we require is not so much theory as practical agriculture. The Colonial Sugar Refining Company has set us an excellent example in its system for the small tenant farmer. They teach their men how to cultivate, how to rotate crops, and especially they see that they do it. That is all important. That is what is meant by practical assistance of agriculture, and to get practical results requires adult education. Education is very much to the front at the present time in Fiji but I think we should go further than just teaching the "three R's." We should teach the people to live on the soil. It is an excellent thing to teach the young children to read and write, but it is no good to teach only the small boy how to grow potatoes because if he went home and tried to instruct his father he would most likely be cuffed, but if you teach the adult labourer and the small tenant farmer about agriculture his son will learn from him. We have quite a number of interesting papers before us and I will call upon Mr. Barnes to read his paper on "Fruit Production for Export." When the papers have been read I would ask that any persons who are interested in the various papers to take part in the discussions and ask any questions that may occur to them.

Mr. Barnes.—Before proceeding to read the paper which stands in my name I wish to thank Your Excellency for the very keen interest you have taken in this Conference and its objects, and your kindness in consenting not only to open the Conference this morning but to give your most valuable time to be present throughout all its sessions. On behalf of my staff I wish to say that we deeply appreciate this kind thoughtfulness on your part.

FRUIT PRODUCTION FOR EXPORT—PART I,—CITRUS FRUITS.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E., Superintendent of Agriculture.

YOUR Excellency, ladies and gentlemen,—I wish to state that my object in preparing this paper for this Conference was to endeavour in the first place to stimulate interest in the growing of citrus fruits for export, and to provide an outline of information for the few people who are keenly interested and who in one or two cases have already taken steps to establish small plantations. I can assure anyone interested in this particular subject that the staff of the Department will be happy to render whatever assistance they can in any way, both in the more theoretical form of lending literature and the practical manner of giving what instruction is possible actually on the ground.

INTRODUCTION.

The cultivation and export of citrus fruits is a subject which has engaged the attention of many of the Colonies and Dominions for some years past. The Union of South Africa, for example, is now one of the largest suppliers to Great Britain and the industry there is very well organised. Fiji by reason of its situation in the tropical belt, its climate and its soil is eminently suited to the production of all grades of oranges, grape fruit, lemons and limes suitable for overseas markets. Although it is unlikely that such an industry will ever assume the same importance as sugar or copra in the Colony, it is nevertheless worthy of a place amongst the more important agricultural industries here. Fiji has before it the lessons learned under great difficulty and expense in other Colonies and should be able to embark on this industry without experiencing so many of the set backs that have jeopardised its success in other places in the past. With any product intended for sale it is essential to establish a standard quality which can be maintained. Any marked irregularity in the quality of fruit offered for sale in overseas markets will seriously affect the esteem with which the public regards that fruit and unless a marketable standard is maintained the whole year round the product is not likely to command a ready sale. Popular varieties of fruit must be grown under carefully controlled conditions; they must be properly harvested at the right stage of development, carefully handled, cured, wrapped and packed in attractive containers for export. Neglect of the most careful attention in every stage of the development of the tree, the harvesting, treatment and export of the fruit will influence the price and the degree with which the product can maintain its place in the market. In this paper a brief outline of the whole process of the production of fruit for export from the establishment of the nursery to the shipment of the fruit will be given.

Plant Propagation.—Though excellent fruit is produced from seedling trees, fruit from different trees is never of uniform quality. The fruit varies in size, texture, flavour, number of seeds and in other characteristics and it is not possible to supply market requirements from the fruit of such trees. It is therefore necessary to resort to some method of propagation whereby a fruit of standard characteristics can be obtained from many hundreds or thousands of trees. This involves some form of vegetative propagation. In the case of citrus, budding is normally practiced. Root stocks are raised from sturdy varieties, generally rough lemon or sour oranges, and are budded at a height of nine inches from the ground when the young plant is about the thickness of a pencil. The best season for budding in Fiji will probably be found to be September–November. Seeds may either be planted in rows and transplanted 18 in. by 18 in. when they are big enough, or they may be planted 18 in. by 18 in. in the first place and budded without transplantation when they are sufficiently well grown. The latter method saves labour and so long as weedy and weak plants are not budded, may be regarded as quite satisfactory. It is, however, essential to utilize only sturdy stocks of a good habit of growth. The young root stocks should be trained to a single stem and branching growth checked in the early stages. This results in much sturdier growth and is likely to influence beneficially the budding operation later to be undertaken. The technique of budding is simple and can be readily picked up after a few trials. Bud wood should be very carefully selected from mature trees of the varieties it is desired to propagate which have borne fruit for several seasons. Bud wood should only be taken from trees of sturdy growth which are known to yield good crops. The wood from which the buds are taken should be one year old.

The buds after insertion in the stem of the root stock should be carefully protected from rain and sun. A binding of tape soaked in a composition of resin, beeswax and tallow should be used and an inverted leaf tied over the bud to protect it from the sun. When the bud has properly united with the stock the upper part of the plant should be cut half through on the budded side and bent over in the opposite direction to force the bud. As soon as the bud has formed a sturdy shoot the stem of the root stock should be cut through a few inches above the bud and as the shoot from the bud or "scion" further develops, the root stock should be cut back carefully with a slanting cut just above the union and the cut surface treated with tar or paint to prevent any access of water. The budded plant will be ready for removal to its permanent home after about two years, but considerable care is necessary during the whole of this period. The "scion" should be trained in the early stages to a single strong stem which should not be allowed to branch too much subsequently. Watering must be practiced whenever the rainfall is insufficient to keep the ground moist. This applies throughout the whole proceedings from the time of the early sowing of the seed until the plant is properly established in its permanent home. Propagation by layering from good trees is another method recommended by some authorities. The technique of this process is described in standard works on fruit culture.

Planting.—The land selected should be well drained, with a free working soil which should be thoroughly cleared of all growth and well cultivated to a depth of 6in. to 8 in. Planting distances for citrus varieties vary from 15 ft. by 15 ft. to 24 ft by 24 ft., usually 18 ft. by 18 ft. or 20 ft by 20 ft. will be found satisfactory. The ground should be carefully lined up and holed some time before the planting operation is to be undertaken. The holes should be 2 feet in diameter by 2 feet deep. When the budded plants are removed from the nursery they should be carefully pruned back to leave only a few strong shoots at the top. The stem for a distance of 18 in. to 2 feet should be quite free from any branching growth. The roots should also be pruned. In planting it will be found that a planting stick is of great assistance. This should be notched in such a manner that two notches correspond with the outer edges of the hole and a notch midway between with the centre. By placing the planting stick across in such a manner that the centre notch is exactly over the middle of the hole it is easy to hold the plant in such a position that it will be planted to the same depth as in the nursery. Surface soil only should be used for filling up the holes and should be carefully worked round the roots by hand, then trodden down in layers in such a manner so as not to cramp the roots or to damage them. It is essential that the plant should not be put in to a greater depth than it was when in the nursery. Shallow planting is much less dangerous than deep planting and allowance should be made for subsidence of the soil in the hole. Collar rot, a serious source of loss of trees, is largely avoided in this way. Care should be taken as planting proceeds to check the lining in all directions, as nothing looks worse than a badly laid out plantation. A good surface mulch should be maintained around the plant and the space between the plants kept under cover either by planting a suitable catch crop or by growing a nitrogenous cover crop. Given satisfactory conditions the plants will soon become established and will give signs of vigorous growth. All shoots which appear on the main stem should be rubbed off with the thumb and finger and should never be allowed to reach the stage where it is necessary actually to cut them with a knife.

Care of Trees.—The plants should be carefully watched to ensure that they develop into well shaped trees and should as a rule be allowed to fork

in only two directions. Subsequent forking of the main branches should, if necessary, be carefully controlled. The object is to get a well shaped tree to all parts of which light and air can obtain free access. In this way the incidence of any disease will be minimised and the tree assisted to bear the maximum quantity of fruit. The trees may be expected to bear fruit in about three years, but for the first one or two seasons the flavour of fruit may be influenced by the nature of the original root stock which will be superimposed upon that of the fruit of the trees from which the buds were taken. This somewhat objectionable characteristic disappears after one or two seasons when the tree settles down to produce a uniform quality of fruit.

Harvesting.—Harvesting of citrus fruit when carried out in a proper manner is not so simple an operation as it would appear. It is essential that fruit be harvested dry and free from dew or mist deposited on the surface. Fruit should always be cut from the trees by special clippers leaving a short length of stalk attached to the fruit. The stem is then again cut as close as possible to the fruit. The harvesters should wear gloves in order to prevent damage to the skin, which is one of the greatest sources of the rotting of fruit by infection of the scratches caused by careless handling as it is cut. The fruit should be loosely packed in boxes fitted with handles for ease of carrying and when boxes are filled they should be transported to the packing station in such a manner as to prevent any bruising of the fruit.

PACKING STATION OPERATIONS.

(*a*) *Curing.*—The subsequent treatment of the fruit depends largely on the requirements of the market and the time necessarily elapsing between the packing and the consumption. In the case of Fijian fruit it would probably be satisfactory to omit one or two of the operations practiced in those countries which supply fruit to more distant markets than those which are available to Fiji. On arrival at the packing station the fruit should be placed in a dry, cool, well ventilated situation for about two days. During this period surplus moisture passes off from the skin, which becomes somewhat toughened and rendered less susceptible to injury in the subsequent operations.

(*b*) *Sorting.*—This consists in the culling of diseased, damaged and otherwise unsuitable fruit for export. Any such fruits overlooked during the initial sorting are removed during the sizing and packing stages.

(*c*) *Artificial Colouring.*—This is often practiced when the fruit as ready for packing is green or irregularly coloured. The object is to obtain a uniform colour of the skin, a condition which greatly adds to the attractive appearance of the fruit. The ripening of the fruit and development of sugar in the juice are speeded up by the process which is now carried out by treatment with ethylene gas in a special manner.

(*d*) *Washing &c.*—In some instances the fruit is washed, brushed and dried by mechanical means, a solution containing chemicals which prevent the subsequent growth of mould being sometimes used. Grapefruit is afterwards coated with a very thin layer of wax to enhance its appearance.

(*e*) *Sizing.*—The sorting of the fruit into sizes is done mechanically and the types of machinery used vary with the output of the station. The object is to secure fruits of uniform sizes for packing. This operation cannot be carried out by the hand and eye without mechanical aid, which may however be of quite simple design. With properly sorted fruit, packing is greatly simplified and the standard size of boxes used hold definite numbers.

of fruit varying from box to box in accordance with the diameter of the fruit. The standard "packs" for South African fruits are given in 21 (*g*) of the extracts from Fruit Export Regulations.

(*f*) *Wrapping and Packing.*—Each fruit is wrapped in thin, tough white tissue paper, cut to sizes suited to the different "packs." The printing of an attractive design on one side of the paper adds to the pleasing appearance of the packed fruit. When wrapped, the design should be on the outside. The whole fruit is covered by paper which is fastened by a firm twist at each end. The operations of wrapping and packing are usually carried on together as the fruit leaves the sizing machine. The method of placing the fruit in the boxes depends on the size, and special printed instructions are used by packers. Loose packing is at all costs to be avoided as the fruit is bruised and spoiled in transit to the market. Standard packs more than fill the boxes, and pressure is necessary to force the fruit down before nailing on the lid. Presses are often used for this purpose. Boxes are of uniform size and constructed to a standard specification.

Inspection and Export Control.—Fruit-exporting counties have realised the necessity for systems of strict inspection and control. In the earlier stages these often appear to bear harshly on exporters, but in the long run their advantages are so obvious as to need no recommendation. They are entirely in the best interests of producers, exporters and consumers.

The following extracts from the latest regulations under the Fruit Export Act 1914 of the Union of South Africa illustrate some of the matters requiring legal enforcement if a fruit export industry is to succeed in holding a satisfactory position in the World's markets:—

REGULATIONS.

1. No fruit intended for export shall be inspected under these regulations unless the requirements of the Perishable Products Export Control Board in respect of the registration of the name, address, distinctive brand and number of the person intending to export citrus fruit, *and of the rendering of estimates of intended shipments shall have been compiled with.—Vide* Regulations Nos. 25 and 26 of the Perishable Products Export Control Board, which are contained in the Appendix hereto.

2. For each consignment of fruit examined by the inspector the exporter shall pay at the rate of one shilling and four pence per 40 cubic feet of packages of fruit.

(Attention is also directed to Government Notice No. 1,452 of the 4th September, 1922, prescribing a special fee of 5s. per 40 cubic feet to be paid in respect of the inspection and grading of citrus fruit exported).

5. Every box of fruit submitted for inspection must be consigned to the person or agent appointed by the exporter to arrange the shipment thereof from the various ports, and every consignment shall be accompanied by two Fruit Consignment Declaration Export Notes, in which all the specifications required are given.

6. Boards of reference, composed of persons whose names have been approved for that purpose by the Minister, have been constituted at the ports of Capetown, Port Elizabeth, East London and Durban, and will be established at such other places as may be necessary, to which an exporter may appeal if the inspector refuses to brand or stamp any box of fruit belonging to such exporter.

7. A fee on the basis of 10s. per one ton or portion thereof, and for any quantity over one ton 5s. per ton extra, with a maximum of £5 10s. shall be deposited with the inspector by the consignor of each consignment of fruit upon which the consignor may require the inspector to obtain the decision of the Board of Reference under the provisions of Sections 5 of the Act.

8. The consignor shall, within twenty-four hours of the time of receiving the inspectors' notice remove from the place of inspection any fruit which the inspector has refused to brand or stamp, or which, having been referred to the Board of Reference, has been decided upon by the Board in favour of the inspector. Whenever it shall appear that there is a danger of rejected fruit contaminating other perishables the Fruit Inspector may require the consignor or his agent to remove such fruit forthwith.

(*Note.*—Attention is invited to Section 6 of Act No. 17, 1914, empowering the Inspector of Fruit to destroy or otherwise dispose of fruit rejected by him for export which is not removed from the place of inspection within the period prescribed by the regulation and providing that any expense of storing pending removal shall be a charge against the owner of such fruit).

9. Boxes of fruit marked so as to represent a grade higher than the correct grade shall be re-marked by the Inspector, and, if otherwise complying with these regulations, branded or stamped by the Inspector as provided in section 4 of the Act.

11. Not less than 5 per cent. of the boxes of fruit in each consignment shall be opened by the Inspector for examination, and all boxes so opened shall be stamped by the Inspector to that effect.

12. Only new and clean boxes or packages shall be used by exporters.

13. Provides for the special marking of boxes.

16. Citrus fruit shall be packed in boxes, the size of which shall be:—

ORANGES AND GRAPEFRUIT.

Outside measurement.—26 in. by 12 in. by 12 in. (with centre piece).

Wood required.—Ends and middle piece (three pieces), 11½ in. by 11½ in. by 11/16 in. Top, bottom and sides (eight pieces) 26 in. by 5½ in. by ¼ in. Cleats (two pieces) either 11 in. by ¾ in. by ⅜ in. or 11 in. by 1 in. by ½ in.

(The ends of orange boxes and grape fruit boxes are to be firmly fastened together with metal fasteners. No ends or centre pieces are to be made of two pieces of equal width. Cleats for grape-fruit boxes must be coloured red).

(*b*) *Naartjies.*—Outside measurement, 26 in. by 12 in. by not more than 6 in. deep with centre piece. For the export seasons 1928 and 1929 boxes 18 in. by 12 in. by not more than 4½ in. deep will be permitted but not thereafter.

(*c*) *Lemons.*—Lemons may be packed in any of the standard citrus packages.

(*d*) All boxes shall have cleats on the lids. The 12 in. deep boxes shall be strapped at each end and in the middle, but the shallower boxes need not be strapped. The strapping shall be nailed over the cleats, but the middle of the lid shall not be nailed to the centre piece. Wire-bound boxes shall not be allowed.

18. Each citrus fruit shall be wrapped in tissue or other similar paper. If wrappers are descriptive of any particular variety of citrus, such description must agree with the fruit contained therein.

21. The following shall be the grades for the fruits mentioned:—

A—ORANGES.

(*a*) "Fancy" fruit shall be that which is free from all blemish and injury.

(*e*) *Maturity.*—No oranges shall be exported unless—

(i) they have attained 70 per cent. yellow or orange colour;

(ii) they show on test not less than the following ratio of total soluble solids to acids:—

Seedlings	5·0	1
Valencia and other late varieties ..	5·5	1
Navels	6·0	1

(*f*) *Minimum weight.*—The minimum weight of boxes of sizes 80 to 126 shall be not less than 74 lb and all longer counts must weigh not less than 77 lb per packed box; the net weight of the fruit shall be not less than 64 lb and 67 lb respectively.

(*g*) *Size.*—The size shall not determine the grade. The sizes of fruit shall be as follows:—

Counts of	80	per box, average diameter	3⅛ in.
,,	96	,, ,,	3⅜ in.
,,	112	,, ,,	3¼ in.
,,	126	,, ,,	3⅛ in.
,,	150	,, ,,	3 in.
,,	176	,, ,,	2⅞ in.
,,	200	,, ,,	2¾ in.
,,	216	,, ,,	2⅝ in.
,,	226	,, ,,	2 9/16 in.
,,	252	,, ,,	2½ in.
,,	288	,, ,,	2⅜ in.
,,	324	,, ,,	2¼ in.
,,	344	,, ,,	2⅛ in.
,,	360	,, ,,	2 in.

Literature.—A wealth of literature on the varied aspects of citrus growing is available in the form of standard works by authoritative writers and pamphlets issued by Universities and Departments of Agriculture in many countries. A list of such books and papers is kept at the office of the Agricultural Department in Suva. Assistance to those desiring more information than the cursory outline given in this paper will gladly be rendered.

DISCUSSION.

His Excellency the Governor.—I am sure we have all listened with great interest to Mr. Barnes. I recommend to the notice of the Planters' Association what he says about the matters of standard quality and inspection and control. These things are governed by Gresham's Law—a bad coinage drives out a good. In the same way if you allow bad fruit to get on to the market from Fiji your good stuff is tarred with the same brush and you get inferior prices. I can quote an example of the importance of control and inspection in Hong Kong. There the Government guarantees by certificate the quality of tin. The tin is brought into Hong Kong from away back in the hills, sometimes 100 miles distant and a certificate for 99 per cent. fine is given. That certificate is accepted without question all over the world. In the same way you have the Sun Kist Oranges, which are fruit of the first quality. The people of California refuse to ship any fruit that is not of first class quality.

Mr. Faddy.—Where would be the principal markets for citrus fruits grown in Fiji?

Mr. Barnes.—In my opinion the principal markets for Fijian citrus fruit would be New Zealand and Australia. I am aware that New Zealand grows part of its own requirements. As I mentioned in the early part of the paper I do not assume for a moment that citrus production in Fiji will reach large proportions, but I think it is well worthy of consideration.

Mr. Faddy.—At one time we were in the fruit industry in Sydney and we noticed that oranges and mandarines from the islands were very difficult to sell on account of the fact that they were green in colour, and it appears to me that if the citrus industry in Fiji is to be a success it would be necessary to overcome this difficulty by colouring the fruit in some way. The same objection exists in New Zealand.

Mr. Barnes.—Mr. Faddy has raised a very important question. It is a point with which I dealt in the paper when I mentioned the fact that some markets demand a normally coloured fruit. Colouring can be done by comparatively simple artificial means. I would despair of ever succeeding in the education of the British public, whether at Home or in the Colonies to eat green fruit. There is a rooted objection which has been passed down for generations to the eating of green fruit. The cheaper method would be to colour the fruit and send it to them as they like it rather than try to make them buy it as we think they ought to buy it.

Mr. Macdonald.—We have the fruit fly in Fiji which necessitates the early picking of citrus fruit intended for export.

Mr. Barnes.—It should be possible to overcome this difficulty. The matter requires study by the scientific staff.

Mr. Surridge.—The following points occur to me as arising out of your paper on Citrus Fruit:—

1. *Time of budding.*—You state September to November. Would not this be too early for most parts of these islands? I should think November and December.
2. *Budding tape.*—You suggest a resinous tape for the necessary budding. Would not clay or a mixture of cow dung and clay, both substances usually to hand on a plantation, answer the same purpose?
3. *Distance of planting.*—You give a minimum of 15 feet each way. Some parts of Australia plant 12 feet apart. Which do you advise? Also, would you favour the quincunx system of planting, *i.e.*, the equilateral triangle, as against the square system? Either allows for cultivation between the trees, but the quincunx is more economical of space.

4. *Depth of planting.*—In planting young stock, is it not advisable to use the " nursery mark " as control on depth of planting ?
5. *Grading of Fruit.*—In dealing with the question of grading, the wholesaler and general public only have been mentioned, but the major loss of bad packing falls on the retailer who, in purchasing, has to stand the loss of bad fruit while maintaining his prices at competitive rates.

Mr. Barness.—The points raised by Mr. Surridge are most interesting and many of them are vital, I think, to the subject under discussion. In regard to the question of the time of budding, I cannot say that I have yet had any experience of any type of citrus fruits in Fiji, but I have discussed the matter with people who have done a certain amount of work here. Mr. Hayes of Sigatoka has budded during the time stated in my paper with excellent results. In connection with the type of budding tape I mentioned, that, I may say, is one of many which is used for the purpose. Reference can be made to any of the standard books on the subject of citrus growing. I would strongly recommend that some such material as that mentioned in my paper should be used in preference to clay or cow dung. The object of the budding tape is to bind the stem firmly and at the same time to prevent the access of moisture to the wound or inserted bud. With regard to the distance of planting, this is a matter which is the cause of some contention amongst planters. I prefer the quincunx system as it allows of planting more trees at the same distance apart in a given area. The distances 9 ft by 9ft. and 12 ft. by 12 ft. mentioned by Mr. Surridge are far too close. Trees for the first years' growth have ample room for all their requirements, but after four or five years they become so overcrowded that there is the tendency for them to grow high in order to catch the sunlight with the result that the trees have comparatively thin branches which cannot bear the load of fruit that a properly grown tree will, and difficulty in the harvesting of the fruit is caused. In regard to the depth of planting, citrus is subject to collar rot, and though the " nursery mark " is a guide to planting depth, it is preferable to have this slightly above ground level rather than below it.

Mr. Caughley.—I would like to ask Mr. Barnes about the extraction of the juice of the limes.

Mr. Barnes.—This is a point which was considered by a predecessor in my office many years ago who imported a cider press for the purpose of expressing the juice. That press is still at Nasinu. The expression of the juice of the lime and lemon has attained great importance in Sicily and the West Indies. For Fiji to embark upon this industry would involve the establishment of large plantations of different varieties of the fruit mentioned and the industry would demand a high degree of organisation followed by some method of penetrating the market. I think it would be more profitable to go for the fresh fruit markets at first.

Mr. Blackie.—Apparently a great deal of labour would be entailed in the proper control of citrus trees, necessitating expert supervision. Would the products be a marketable success from this point of view ?

Mr. Barnes.—This question also is of importance. As I mentioned, I have prepared this paper with the object of interesting people. The degree of organisation should not be very great in the early stages. Everything would depend on the quality of the fruit which was grown and sold in the export markets. There is no reason why the quantity offered for export should not be increased and the quality improved.

Mr. Faddy.—Raised the point about a regulation being in force that prevented anyone sending citrus fruit to Australia in excess of the quantity shipped the previous year and that one year a gentleman could only ship one case of oranges because that was the quantity shipped the previous year.

Mr. Duncan.—The whole question boils down to one of markets. There is no Australian market for Fiji citrus fruits.

Mr. Barnes.—I think there is one important point that has been overlooked and that is the question of the local market. That is a point which is well worthy of attention in the near future. In South Africa, one of the homes of the citrus industry, the industry is highly organised. Growers and producers have formed co-operative societies in the various districts and there is practically no individual marketing of fruit. It should be possible to work on similar lines in Fiji to ensure that local demands are supplied.

Mr. Barker.—Raised the question about the prohibition of the importation of limes into New Zealand.

Mr. Barnes.—I am not aware that there is any prohibition of the importation of limes into New Zealand. I will look into this matter. All these questions require to be explored before embarking upon an industry of this description.

His Excellency the Governor.—I now ask Mr. Anson to read his paper on the Cotton Industry.

RESUME OF WORK AT THE COTTON EXPERIMENTAL STATION.

By R. R. ANSON, Cotton Specialist.

ON the recommendation of Mr. G. Evans, who made a thorough tour of the Fiji Islands during July and August of 1924, I was appointed by the Empire Cotton Growing Corporation and attached to the Government of Fiji as Cotton Specialist. The primary object of my appointment being that of plant breeding on cotton, with a view to raising new and improved types, together with testing new varieties and carrying out experiments on the cultivation. Several varieties have been tried out at the Experimental Station, including:—

Kidney *Gossypium Braziliense* which was obtained from seed found growing locally and is a perennial shrub or small tree with united or conglomerate seeds and possesses coarse lint used mainly for mixing with wool. The staple measures from 1 in. to 1½ in.

Meade *Gossypium Hirsutum.*—A variety which originated from a single plant selection made in 1912 by Rowland Meade from a field of Black Rattler. It was introduced into the Sea Island areas of Georgia and South Carolina because Sea Island could not be grown profitably in the regions infested with boll weevils.

Tanguis *Gossypium Peruvianum.*—Produced originally about the year 1908 by Senor Cermin Tanguis. It is said to be a Hybrid of Egyptian and Semi Rough Peruvian. It is usually grown under irrigation and the staple averages 1-3/16 in. to 1¼ in.

Acala *Gossypium Hirsutum.*—An American upland variety evolved by G. N. Collins and C. B. Doyle in 1906 from imported seed from Southern Mexico. The present strain was developed from twenty selected plants by Dr. D. A. Saunders, and our seed was obtained from Australia.

Pima *Gossypium Peruvianum.*—An American-Egyptian variety grown, mainly in Arizona and California and used for manufacturing of tire yarns balloon cloth and aeroplane fabrics.

Sakellarides *Gossypium Peruvianum.*—An Egyptian cotton which was brought out about the year 1907 from a single plant selection from Jannovitch.

Several of these cottons have been crossed with Sea Island.

The only ones which have shown any promise of becoming commercially successful are:—Sea Island, Kidney and a Hybrid Sea Island Kidney cross, which originated from five of the most promising of twenty-eight single plant selections made by Mr. Evans from Kidney Hybrid cottons found growing at Kayapet, Markham Valley, New Guinea. Of the original twenty-eight selections sent out by Mr. Evans eleven possess conglomerate seeds which did not cling together as in ordinary Kidney cottons. Five of these which appeared to be the best were sent out to Fiji by the Empire Cotton Growing Corporation for trial.

During the past few years the uncertainty of the market for Sea Island cotton made it necessary to try out experiments in order to ascertain whether it will be possible to substitute it by some other variety which would be more saleable, and at the same time, give the grower as good a return per acre.

It is well known that owing to its length, strength and fineness of staple, Sea Island has always commanded a higher price than other cottons, but the size and character of the bolls make picking difficult, and a picker can rarely maintain an average of more than thirty pounds of seed cotton in a ten-hour day. A cotton that will compare favourably with it, from a grower's point of view, must therefore be a type which possesses a larger boll, a higher percentage of lint, a higher percentage of first-grade cotton per acre, a better yielder, and at the same time produces a lint of such quality that the price will be as close as possible to that of Sea Island.

The average percentage of Sea Island A and B grades taken during the first four seasons has been high—69·41 per cent.—and it will not be an easy matter to find a cotton which will beat this. The grade and class are governed to a great extent by weather conditions at the time of maturity, the dryer the weather at picking time the higher the percentage of good quality cotton. According to the rainfall statistics taken over a period of twenty years in the dry zones of Vitilevu and Vanualevu Islands the dryest weather was experienced during the months of June, July, August, September and October. The Sea Island crop when planted in mid November usually reaches maturity in April and picking is continued until the end of August. The Kidney Hybrid planted at the same time does not reach maturity until June and picking is continued until the end of December. This fits in with the dryest months and it is hoped that it will be possible to obtain a higher percentage of first grade cotton than is the case with Sea Island. As far as the present season is concerned this seems to be precisely the case, and the Kidney Hybrid has so far shown many of the other characteristics which are necessary to make it compare favourably with Sea Island, that is *from a grower's point of view,* but the variety, has not been properly fixed to type and a few individual plants show signs of reverting to one or other of the parent plants and it will be necessary to continue with plant selection work until the type has become commercially pure.

For the ultimate fixing of a commercially pure type, the method adopted by most plant breeders is that of the "progeny row" system, which is one based on the separate raising of progeny of individual selected plants. To begin with several plants are selected as being the best to be found, and the seed from each of these is saved separately. The reason for having more than one plant to start with is that the degree to which the characters

of the parent are transmitted are found to vary with different plants. The following year each of these lots of seed is used to establish a row of, say, one hundred plants. The rows should be adjacent to each other and should either occupy an isolated position or be placed amongst cotton of good type. These precautions are taken to prevent, as far as possible, the crossing with pollen from inferior plants. Any plants of noticeable inferiority are pulled up as soon as detected. When plants come into bearing the rows are compared with each other, and the rows which possess the required characters with the greatest regularity are selected. In these again a number of the best plants are marked and the seed from each individual saved separately for next three years' rows. The seed from the remainder of the plants in each selected row is saved and used for planting separate plots, while that from the non-selected rows should also be kept for planting since it may be expected to be above the average. The following year there will be:—

(1) a new set of rows from the last selected plants;
(2) as many seed plots as there were selected rows in the previous year;
(3) a certain amount of cotton planted from seed from non-selected rows.

For reasons connected with crossing already indicated, the seed plots should be planted around the rows. The selection of rows and individual plants, and the planting of seed plots, are repeated in this and each succeeding year. From the seed plots sufficient seed will be obtained each year to plant out a large field. If the seed from this is not sufficient for an isolated community of growers, the process can be carried on another step, using the area upon which the seed cotton is grown as the seed plot for the following year.

A study has been made of the behaviour of each hybrid plant in the progeny rows. All the free-seeded ones were grouped together and careful observations made. Points such as pest resistance, productivity, size of boll, length and uniformity of staple and flower colourings, &c., were noted.

Two plants were selected as being the most uniform and desirable and the seed obtained from these has been planted on increase plots at the Station. Seed from the former, namely K. 3-2., has been chosen for distribution to growers during the current season. This means that the seed from an individual plant has in two years been multiplied up to meet the requirements of all cotton growing areas in the Sigatoka district, roughly 600 acres.

The type of plant which we are attempting to produce is a robust one of open habit, with full opening bolls and strong lint of uniform staple length, resistant to Black Arm *Bacterium Malvacearum* and other fungi encouraged by excess of wet and humidity of which we have so much here. It appears to me that our safest plan would be to produce two types:—

(1) a coarse stapled cotton measuring about 1¼ in. which could be used for mixing with wool;
(2) a fine stapled cotton measuring about 1½ in. which could be sold against Egyptians.

At the present time both of these types are selling well in the English market. To my mind it is desirable to have as it were, two strings to our bow, so that should one type drop in price we would have a supply of seed from the other and would be able to put it on the market in a short space of time. There is always a danger of wool prices having a direct influence on the price of the rough cottons, and of over production in Egypt and the Sudan influencing the price of Egyptian types. All selection work at the Station has been carried out with this end in view. The best of the coarsest counts have been selected, self fertilized, and planted out on isolated plots in progeny rows.

Self Fertilization.—In order to ensure self fertilization it is necessary to take the flower buds during the evening or early morning before they burst open, and by means of a silken thread being securely tied around the corolla they are prevented from opening. One end of the thread is attached to the stem above the peduncle. The flowers of cotton plants are known to a botanist as complete in that they possess both male and female organs necessary for reproduction. During the afternoon of the following day the stigma becomes receptive and fertilization takes place. No pollen from the surrounding plants has been allowed to enter as the flower has never opened. After about three days the corolla withers up, drops off and hanging by the thread, which as I said before had been attached to the stem above the peduncle, it acts as a label.

In order to obtain the fine type, we have back-crossed selected plants with Sea Island and the seed obtained has been planted in single lines where it will be self fertilized and again selected from during the coming season.

Crossing.—Crossing is a much more tedious business and can only be done by a person who has been thoroughly trained to the work. Flowering buds are taken two days before they are due to open. One petal is removed by means of a fine pair of scissors. The flower is then emasculated, care being taken to see that the anthers have all been removed, and in order to ensure that it cannot be visited by pollen-carrying insects, the flower is then covered by a thin paper bag. On the following afternoon a few flowers are taken from the plant chosen for crossing and pollen from them is placed on the stigma of the emasculated flower. The bag is then replaced and not removed for two days when the young boll is labelled by means of a piece of coloured thread being tied around the peduncle.

Dr. S. C. Harland, Geneticist of the Corporation's Research Station in Trinidad, has kindly supplied some seeds from a Kidney Sea Island Hybrid which has been back-crossed with Sea Island. These have been planted out and their behaviour will be watched with interest. In comparing the two varieties I have taken the highest plot yields obtained last season at the Station for each. With regard to Sea Island I have taken the average price obtained for all grades since the recommencement of the industry, and an estimated average price for the new cotton. Working on this basis we find that—

(*a*) one acre Sea Island yielded 1,228 lb of s/c at 3·05d.=£16 8s. 8d.

(*b*) one acre New Variety yielded 1,794 lb of s/c at 2·5d.=£18 13s. 9d.

In two years we hope to bring the quality of the new variety up to an average value of 13½d. per lb. The average purchasing price of one pound of lint at the present rate is estimated at 7½d. The cost of ginning and marketing on a 918 bale crop in 1926 was 5·13d. per lb. This means that should we reach our goal a profit of ·87d. plus the prices obtained for cotton seed would be made on every pound of cotton sold.

Judging from reports received from the British Cotton Growing Association there is likely to be a constant demand for up to 10,000 bales of this variety, whereas if we were to produce more than 1,000 bales of Sea Island we would probably flood the market, but at the same time, it would be advisable to keep a stock of pure Sea Island seed on hand in case there should be a good demand for it at some future date, and it should prove more profitable to the growers than the new type. In order to do this it would be necessary to confine an isolated area to the growing of it exclusively and to gin and store it separately. At present it is being grown between Ra and Cuvu and stored and ginned at Lautoka. My own opinion on the matter is that

we would be able to dispose of up to 2,000 bales of Sea Island cotton at a price which would pay both the grower and the ginners, but it is a variety which would not be grown extensively by Fijians, mainly because it is a difficult cotton to pick and needs to be carefully picked over again before it is forwarded to the ginnery, and I am afraid that the work would prove to be too tedious for the Fijian temperament.

If cotton is to be grown by Indians alone it would be a considerable time before the output exceeded 1,000 bales, because consolidated areas settled by Indians who are not engaged in growing either sugar cane or pineapples are few and far between and on account of transport difficulties and costs, it could not be grown profitably by those whose holdings are situated at any great distance from the ginning centres. I am therefore in favour of confining Sea Island to the districts between Ra and Nadi on the western coast where it can be dealt with at the Lautoka ginnery and there need be no fear of the two varieties being mixed.

With regard to the new variety (which can be picked twice as easily), Fijians, if given a little encouragement and training, should be quite capable of producing up to 500 bales in the districts of Nadroga and Colo West alone. Each year they are becoming more and more interested and it is encouraging to see that a number of them have been growing cotton for the last three seasons. In order to stimulate their interest it might be a good thing for the province to provide villages with agricultural implements on the understanding, or rather, written agreement, that the implements would be paid for from the proceeds of the crop at the end of the season. The time limit for payments might be extended over one or two seasons according to the area and yield of the crops concerned. Having firmly established cotton growing on this island we would be in a position to concentrate on some of the other islands.

An important fact which should not be lost sight of is that it is not advisable for a grower to depend upon cotton alone for his livelihood. It should be grown in conjunction with other crops and rotated with a legume. At present with perhaps the exception of tobacco, other than perishable crops, such as maize and tomatoes, there are not many being grown. In order to encourage the growing of them it would be advisable to extend the area of the Cotton Station and to make a general experiment station of it, where crops such as ginger, senna, turmerik, groundnuts and onions might be thoroughly tested and distributed to growers if found successful.

His Excellency.—I am sure we all appreciate Mr. Anson's interesting paper and I think, perhaps, that he has not gone far enough in explaining the steps he has taken for the practical application of his teaching to the Indians of the country. I fully endorse what he has said about agricultural implements. I know that Mr. Anson is proceeding on the lines I mentioned this morning. I agree that it is a good thing to put people on the land, to assist them with practical demonstration and to teach them how to rotate their crops. I think valuable work is being done in this direction. I invite discussion on Mr. Anson's paper.

Mr. Field.—I should like it to be clearly understood that the cotton industry is still in an experimental stage. It is now seven years since the revival of the industry; this may seem a long time. The reason for this protracted experimental stage, which should be completed in another two years, is on account of Sea Island cotton having been planted in the first place. This variety has the longest and finest staple that can be produced anywhere in the world, and on account of these qualities it is the most

expensive. The demand for this variety within the past seven years has been limited, and there was some difficulty in disposing of the small Fijian crop. It has been estimated that owing to the falling off in demand for this cotton, it might take as long as eighteen months to two years to dispose of a crop of 2,000 bales after delivery in the United Kingdom. The prices realised up to date for Sea Island cotton have been most profitable to all concerned. However, this has not altered the position and it is still considered to be an unsatisfactory variety to grow as there is the risk of the industry being "saddled" with large stocks of cotton unsold in the United Kingdom. The British Cotton Growing Association advises trying out other varieties and the selection of one that will suit the climatic conditions of Fiji, be remunerative to the grower, and for which there should be a regular demand. This naturally takes time as selection work and cross-breeding, even with the best of luck and under the most favourable conditions, can seldom be achieved in less than from five to six years. Owing to these experimental stages the industry has been more or less held in suspense, and in consequence the preparation, ginning and marketing of cotton in Fiji has been held back and it cannot be said to have reached an economical position from a commercial point of view. Nearly all varieties of cotton have their ginning peculiarities, that call for different types of ginning machinery. Until it has been definitely settled which variety is to be grown generally in Fiji and the crop reaches 1,000 bales, the ginning and preparation of the cotton for export will have to be carried on with the existing plant which is only suitable for Sea Island cotton, but can be made to gin other varieties, though not on commercial lines or on a profit-making basis.

[Mr. Field then described in detail the lay-out and method of operation of the two existing ginneries, one of which is at Lautoka, and the other at Sigatoka].

Mr. Tarby.—Indian cultivators in other islands of the Group are capable of producing cotton and many of them are anxious to do so. How long will it be before this crop can be extended to those places?

Mr. Anson.—We hope first to make a success in this island before dividing our forces. Increased overhead charges and expenditure which would be necessary would be disastrous to the industry at the present time. As soon as we have fixed our policy here and made a success of it, which will take two more years at the least, then we can extend to the other islands. There is really no reason why growers should not plant up on other islands, but the cost of getting the cotton to the ginnery would be greater than the profits reaped by the grower under present conditions.

Mr. Hunt.—What would be the possible return per acre for cotton. We have figures for certain varieties which returned £16 8s. 8d. and £18 13s. 9d. respectively.

Mr. Anson.—The average yield of the new variety would work out between 750 and 800 lb per acre. The average price received by the grower is 2½d. per lb and the return would be £7 or £8 per acre. That is for the new variety.

Mr. Hunt.—What would be the cost of production?

Mr. Anson.—At the Experiment Station the cost is probably a little on the high side. There it works out approximately £3 7s. 6d. per acre.

Mr. Hunt.—Is the cotton industry supported by the Government at present or is it running on its own merits?

Mr. Anson.—The industry is running entirely as a commercial concern at the present time. The prices have been fixed by Government. The

prices for Sea Island are 4d., 3d., 2d. and 1d. per lb; the prices for the new variety are 3½d., 2d. and 1d. per lb.

His Excellency.—I understand that the Government gives a fixed price for the cotton. What is the Government's position when it has sold the cotton?

Mr. Field.—The Government purchases the cotton from the growers at approximately 75 per cent. of its estimated value. After the cotton has been sold and Sales Accounts come through, and all costs have been deducted, the balance is distributed to the growers. I think what Mr. Hunt wanted to know is whether the Government subsidises the cotton industry. The industry is run entirely without Government financial assistance, although I believe the Government gave a grant of £700 at the beginning of the enterprise. Last year there was a loss of £513 which is the first loss since the industry commenced. There was a profit of £8,000 for the 1926–27 crop, when 919 bales were shipped. This profit was distributed as a deferred payment; nothing was placed to a reserve and the cultivators derived the maximum benefit.

Mr. Turbet.—The cultivation of cotton is important from the point of view of obtaining cotton seed for concentrated food for cattle. Mr. Anson states that one company has taken ten tons of seed and are very satisfied with the results. In 1928 I undertook some cattle feeding experiments in Suva with cotton seed and I found that all the animals did well on it. I think cotton seed is a valuable additional food for working stock. I do not know what has been done in the way of endeavouring to crush the cotton seed for the extraction of oil and the manufacture of cotton seed meal.

Mr. Barnes.—The remarks of Mr. Turbet are very interesting, calling attention as they do to the value of cotton seed for cattle food. I would refer him to recent work in America where experiments have been carried out in this connection. With regard to the crushing of cotton seed, one farmer in Suva recently endeavoured to get cotton seed crushed at the local oil mill, but unfortunately they were unable to take the work. Their machinery is adapted for special purposes and an experiment of that nature would disorganise certain sections which is hardly an economical proposition from their point of view. If a steady supply were assured the necessary arrangements could probably be made.

His Excellency the Governor.—I will now request Mr. Stuchbery to read a paper on the Dairy Industry.

PROGRESS OF THE DAIRYING INDUSTRY IN FIJI.

By H. M. Stuchbery, B.V.Sc., Acting Senior Veterinary Officer.

It is now about seven years since the dairying industry was established in Fiji and a review of the progress made during this period may be of interest. It is intended to confine attention chiefly to the progress made in regard to the class of cattle among those herds supplying butter-fat to the three factories, Tailevu, Rewa and Navua, and to the general methods of management by dairymen. It must be borne in mind that there are besides these herds many other herds concerned in the production of milk and butter in which much improvement has taken place, although not perhaps to the same extent as has occurred in those herds supplying these factories. Before the Tailevu dairy scheme was started very few pure-bred stock of a milking strain existed in the Colony. The following figures give a fairly accurate summary of the state of these herds to-day:—

	Tailevu.	*Rewa.*	*Navua.*
Number of herds supplying cream to factory	23	15	14
Number of herds using pure-bred bulls	10	15	9
Number of herds containing pure-bred cows	..	11	4
Number of years factory has been established	7	5½	4

It is safe to say that 90 per cent. of the remainder of the herds use good grade bulls as sires. Generally speaking, too, it is only the small suppliers who are not making use of pure-bred sires. A statement to the effect that in no other Colony would we find such a large proportion of pure-bred stock would be difficult to contradict. It must be remembered also that there are other breeders of pure-bred stock in Fiji who are not included in these figures.

When considering the progress being made in the dairying industry, sight must not be lost of the fact that at the outset these herds were built up hurriedly from whatever stock was available. While many of these may have been quite suitable for the purpose, a great number coming as they did from untried stock, must have been entirely unsuitable and unprofitable. It has fallen to the owner therefore to eliminate these unprofitable cows from his herd, a task which takes years to do in many cases on account of lack of capital and difficulty in obtaining good cows to replace the unsuitable cows. The following figures of the production of cows in the Rewa area may be of interest. These were supplied by the Manager of the Rewa butter factory. These figures were obtained from cows whose morning and evening milk was weighed, sampled and tested:—

30	cows yielded over	50 lb	butter-fat in	30	days.	
10	do.	40 lb	and under	50 lb	in thirty	days.
76	do.	30 lb	do.	40 lb	do.	
289	do.	20 lb	do.	30 lb	do.	
141	do.	12 lb	do.	20 lb	do.	
10	do. under	12 lb		..	do.	

It will be seen that in the Rewa there are still a large number of unprofitable cows in the herds. These figures are taken whilst the cows were in full milk so that their average yield per month for their full milking period would be considerably below this figure. It can be taken for granted therefore that any cow showing a lower production than 20 lb per month in these tests is unprofitable. The same proportion of unprofitable cows would also exist in the Tailevu and Navua districts. It might be said that such a proportion of unprofitable cows does not reflect creditably upon the owners, but several facts must be borne in mind, namely:—

(1) owners have not yet had time to cull their herds sufficiently;
(2) it is difficult for these owners to avail themselves of a subsidiary industry while their herds are being built up;
(3) it is better to have even a bad cow producing a small quantity of butter-fat than to have no production at all.

Dairymen on the whole are quite aware that a number of unprofitable cows do exist in their herds and they are fully alive to increase in profit which could be made with better cows. From the herds of such owners we can expect an increasing yield per cow in the future.

In the dairying industry an important step towards success is supplementary feeding with concentrated foods. Where pastures are of a high nutritious value this factor is not of such vital importance. Whilst pastures are very prolific in our dairying areas in Fiji, it cannot be denied that they are rather low in nutrient value, and hand-feeding foods is sure to be beneficial. In Fiji the supplementary foods obtainable at a reasonable cost are rather limited. The only concentrates at present in

use are coconut meal, rice bran and molasses. Quite a number of dairymen are using these with beneficial results and the number of these users is bound to increase when the benefits obtained from the use of these foods become more widely known, and it would appear that secondary industries producing concentrated stock foods as by-products should find a ready sale for these. At present difficulties of transport and the cost of same, place some dairymen at a disadvantage in the use of these foods, but time will lessen these problems.

In most dairying countries, supplementary industries to the production of butter-fat are an important part of the dairying industry. Up to the present, dairymen in Fiji have not developed this section of the industry to any great extent, the rearing of young stock for butchers purposes being practically the only sideline to the industry. The raising of swine for local butchers purposes offers a good field of investment as between 60 and 70 pigs are imported each month for this purpose A praiseworthy effort is being made by the Fiji Pastoral Company Limited to capture this market, and up-to-date piggeries have been constructed to provide for the breeding of pigs on a large scale. The Suva butchers are anxious to obtain locally-bred pigs as it will not be necessary for them to retain such a large number of pigs at their yards against the next shipment from overseas. At present, however, it would never do for all our dairymen to go into the pig raising industry as the supply would soon exceed the demand. The production of bacon in connection with dairying industry is, however, a source of great profit and the establishment of a bacon curing factory is within the bounds of possibility if our dairying industry continues to expand. The establishment of any industry which will absorb by-products of the dairy industry is sure to benefit and stimulate the dairying industry considerably.

While it is apparent that good work has been done by the pioneers of the dairying industry, often under adverse circumstances, we must not lose sight of the fact that much can still be done to make the dairying industry more productive and profitable. The following points commend themselves for consideration in the future of the industry:—

(1) more extensive testing of dairy heads with subsequent elimination of unprofitable cows;
(2) the improvement of pastures by the elimination of weeds and pests, and the introduction of nutritious fodder plants;
(3) a wider adoption of the principles of handfeeding with concentrated foods;
(4) the development of secondary industries which will benefit the dairying industry;
(5) the adoption of the most up-to-date methods of handling of dairy produce with the strictest attention to all sanitary precautions, necessary for the production of only the purest dairy products.

The successful adoption of all these measures does not lie entirely with the dairymen, and any assistance that can be given to this body of men will ultimately reflect on the prosperity of the Colony.

Butter Production in Fiji.—The following figures taken from the Fiji "Blue Book" give the butter production from the butter factories since 1921:—

Year.	*Amount.*	*Year.*	*Amount.*
1921	15,104 lb	1925	168,844 lb
1922	23,785 lb	1927	302,513 lb
1923	59,219 lb	1928	313,655 lb
1924	143,219 lb	1929 (estimated)	357,000 lb

The 1929 figures are estimated from the production of one factory for 1929 compared with the previous year. It will be noted that there has been a constant and rapid increase in the production of butter every year. The increase in 1928 was certainly only slight, but it must be remembered that the latter half of 1928 was exceedingly dry, and the butter-fat production decreased accordingly.

His Excellency the Governor.—I congratulate Mr. Stuchbery on his interesting paper relating to this important industry. I think the figures which he quoted make most heartening reading. When I was in London I was told that the Fiji butter was just as good as the best New Zealand butter.

Mr. Turbet.—In opening the discussion on Mr. Stuchbery's paper I would first of all like to compliment him on the able manner in which he has reviewed the dairying industry. Fortunately, I have had an opportunity of reviewing his paper. Although it is not lengthy it has the advantage of covering the ground concisely and giving a good lead in the concluding points for a discussion as to the best methods of fostering and improving the industry. Let us consider Mr. Stuchbery's points.

The first is, "A more extensive testing of dairy herds with subsequent elimination of unprofitable cows." The testing here referred to is the recording of the daily and total yield in milk and butter-fat for each cow over a given period, which might be a month or the usual milking period, about 273 days, or a whole year. An accurate record of these returns enables the farmer to ascertain the relative economic values of his cows. Where concentrated feeding is resorted to it can be ascertained whether the cows are giving a fair return for the value of the concentrates used. In the breeding of dairy cattle also, the returns of the cow as revealed by the herd tester give a most accurate guide for the selection of the most profitable animals. In these times when it is hardly the practice to rear all calves born on the farm, those heifer calves, at least, of known high producers should be raised with extra care as on those animals depends the future herd. In larger countries than Fiji it is usual to employ herd testers, either by the Government or by Herd Testing Association. Such an appointment may not be warranted here yet, but good work in that direction is being done by the managers of the butter factories.

The second point is, "The improvement of pastures by the elimination of weeds, pests and the introduction of nutritious fodder plants." If I were to be asked what is the greatest enemy of agriculture and the live stock industry in Fiji? I would reply, "The rapid growth of noxious weeds." I need not dwell on that; the curse of noxious weeds is too well known to all present. Apart from control of weed pests by biological means the only solution to the problem seems to be in limiting the size of the holding to such dimensions that it is within the power of the occupier, either financially or physically, to cope with the annual crop of weeds. Once having cleared his holding of weeds, weeding must be considered as a periodically recurring event in the routine of the farm and in preparing the estimates funds must be provided for that work. The only means of checking weed growth on Fijian-owned land and on large holdings such as Vitilevu Bay, once the weeds invade the district, is by keeping as much of the country as possible covered with the virgin vegetation of the region. Only such areas as can be kept in control should be used. It seems to me of little use experimenting further with grasses and fodder plants of temperate zones. That has been done for decades and I think it can be safely

assumed that all those which will grow are already here. It is in the other milder tropical countries that we should search for such plants. Older established and well-organised tropical countries such as Jamaica, Hawaii and the Philippines no doubt contain many useful fodder plants suitable to our climate which have not yet been introduced here.

The third point is, "A wider adoption of the principles of hand-feeding with concentrated feeds." The concentrates available in Fiji are:—Rice Bran, Coconut Meal and Cotton Seed. Rice bran and coconut meal have been well tried and those dairy farmers who use these concentrates are awake to the increased yield of milk and greater profits which accrue from their use. I have recently had an opportunity of visiting many dairy farms in Australia. I found that all dairies in the vicinity of Sydney are relying solely on hand-feeding, whilst in the country districts many farmers are feeding at least a ration of concentrates. Nearly every farm of any consequence has also installed one or more silos. In this country where it is impossible to store feed as hay I think that the silo offers the best means of storing the better classes of bulk feed or roughage for winter feeding. Maize has been found excellent for silage purposes, but most grasses and herbage can be used. The feeding value of silage is high and it enables dairy cows to produce milk and butter-fat more abundantly. It is estimated also that the use of silage will increase the carrying capacity of a dairy farm by about 25 per cent. The cost of construction is considerable as probably only the tub silo would be efficient in the country. Before recommending their general construction I think that one should be built experimentally. That is a matter which could be gone into further. A feeding experiment with local cotton seed was conducted a few years ago. There is a record of that in the department. The results showed that there was no harmful effect from the feeding of the seed and the animals certainly improved in condition and growth as compared with the control. The matter of crushing the seed locally was gone into, but, I think, found too expensive; however, the whole seed offers a further choice of concentrated feed for our dairy stock. Those who do not feed supplementarily with concentrates should be guided by the experiences of those who do. No doubt there are some present who have had experience.

The fourth point is, "The development of secondary industries which will benefit the dairying industry" Our local dairy farmers have always been under a disadvantage in making their farms pay, as compared with similar farms in other countries. In those other dairying countries there are well-established secondary industries which help to augment the returns of the farm. Chief among these industries is pig raising. It would appear that there is no farmer or body of farmers in Fiji who can guarantee to the butchers a regular monthly or periodic supply of uniform healthy pigs. If that supply existed I am sure that butchers would purchase locally instead of importing. In other words the industry is not organised here. We have abundant feed suitable for pigs in Fiji among which might be mentioned, skimmed milk, maize, rice bran, coconut meal, broken rice, grasses and root crops. That is a fair selection. There is not time to go into the whole business of pig raising now, but I have no doubt that it can be profitably conducted in Fiji. The Veterinary Division is always prepared to advise from personal experience and from literature which is available in the Department. Bacon curing might also be considered as an extension of the pig raising industry. Skimmed milk enters extensively into the manufacture of margarine. The other ingredients of margarine are also produced in the Colony, such as fats and oils. There should be a good

market for the product in Fiji among our Indian community. Another consideration is the coagulation of the casein of skimmed milk, the drying of the same and its export. It is a valuable commodity and is used in the manufacture of many articles. The poultry yard and the banana plot are also valuable adjuncts to the dairy farm.

Mr. Witherow.—I would like to point out that coconut meal is unprocurable in Fiji. The Rewa dairymen were using about ten tons every month and suddenly the supply came to an end. Then there is the question of top dressing in Fiji. Fodder plants in Fiji grow very quickly compared with other countries where it is colder, and I think that this makes the nutritive quality in the grass less here.

Mr. Turbet.—There is no doubt that what Mr. Witherow says is correct, but there is the question of stock licks which is an alternative method of providing the extra chemicals required. We have always recommended stock licks and in co-operation with our Government Chemist we will now be able to ascertain the composition of our fodders and find which chemicals are lacking.

Mr. Hunt.—With regard to the dairying industry in Fiji there is no doubt that you can appreciate the benefit of that industry to Fiji when in seven years there is an increase from 15,000 pounds of butter to 318,000 pounds. I think I am speaking for all the suppliers and the men who are in the dairying industry, and I may say that we quite appreciate all our faults. We also appreciate what standard we can rise to, but in the majority of instances it is a matter that the exchequer controls. The heavy expense of keeping down noxious weeds is a serious handicap. [Mr. Hunt then referred to the Dairy Regulations drawn up by the Medical Officer of Health]. I hope that Your Excellency will afford the dairying industry every possible assistance.

Mr. Barnes.—Perhaps I may be permitted to deal with some of the questions just raised. Regarding the subject of noxious weeds, information has been received from Mr. Simmonds that he will be ready to leave Trinidad with a consignment of the Thrips by the direct steamer which sails from London on 5th February. He will be joining that steamer at Balboa and should reach here about the middle of March. Arrangements have been made for Mr. Taylor to return in time from Java to take over from Mr. Simmonds the work of introducing the Thrips. The old Government Experiment Station at Nasinu will provide an ample supply of the weed *Clidemia hirta* (Koster's Curse) on which to try out the Thrips when they arrive from Trinidad.

In regard to experiments with fodders and top dressings I may say that a small experiment is already in hand and that the Department will publish the results as soon as available.

The local manufacture of margarine has engaged my attention for some little time, since the question of supply to the Indian community of ghee came under consideration. This is a very expensive commodity and costs probably more than butter. It is in fact almost pure butter-fat whereas butter contains a proportion of water. If we can persuade the local Indians to use margarine in place of ghee it will mean the building up of a valuable secondary industry.

In regard to the stoppage of supply of coconut meal I was not previously aware of the fact that it was not locally available and that certain dairymen were anxious to procure it. I can assure interested people that steps will be taken to try to remedy this.

His Excellency the Governor adjourned the Conference until 2.15 p.m.

Conference resumed at 2.15 p.m.

His Excellency the Governor.—We will now continue the discussion on the dairying paper.

Mr. Blackie.—Mr. Stuchbery stated there is a marked improvement in the dairying industry, but I would like to point out that since assuming my duties as Government Analyst I have analysed 40 samples of milk, 60 per cent. of which were deficient in fat and solids not fat. Although undoubtedly many of these were adulterated, yet even the milk from dairies properly controlled, although conforming to Fiji requirements, which are of a fairly low standard, are not equal in my opinion to milk values obtained in New Zealand and Australia. Even two samples from pure-bred Jersey cows gave fat values lower than is usual for this breed.

Mr. Turbet.—The quality of milk is fixed for any particular cow, irrespective of what food she gets. What is altered is the total quantity of milk produced by the cow. In spite of this, however, the quality of milk varies according to the period which has elapsed since calving. It is difficult to explain why there should be a deficiency in any particular pure-bred Jersey cow.

Mr. Barnes.—This question was asked by Mr. Blackie at my suggestion. It is obvious that the quality of milk which is being supplied for public consumption in Suva at the present time is, in some cases, inferior, and it was thought that this would be a convenient opportunity to ventilate the question. Samples have been taken at the time of milking and brought to the laboratory under proper care. It was found that European dairies, which were carefully looked after, had a much higher fat content than the milk supplied by Indian dairies in Suva, where it is obvious that they do not receive attention that is demanded for a dairy supplying milk for public consumption. This is a most important matter from the public health point of view. If the figures which Mr. Blackie obtained are typical of the majority of milk that is available for human consumption then there is a possibility that the standard should be reconsidered. In my opinion the standard is already sufficiently low and it should be possible to maintain a much higher average content of fat.

Mr. Kiss.—Spoke about tests of cows varying at different times.

Mr. Stuchbery.—It is possible that something happened to the animal referred to to make it give a low test on one occasion. It was perhaps frightened by another cow before going into the bail, or it did not yield all its milk.

Mr. Barnes.—I would like Mr. Leaning to give his views on this question.

Mr. Leaning.—Referring to the question of testing, experience in New Zealand over a number of years shows that the testing of a cow once a month gives figures that agree fairly closely with the butter-fat return from the factory. In Fiji we have carried out a series of tests and I am very doubtful whether the average fat production per cow amounts to more than about 90 lb a year. This is very low indeed. Last month we had a record output for our Tailevu factory and the net production per cow worked out at 15·2 lb of butter-fat, which is representative of the whole. An article published by a Herd Testing Association in New Zealand showed that there was one herd of 76 cows produced 67 lb butter-fat per cow during the month, and the lowest yielding herd in the Association produced 18 lb. It was a herd of 37 cows and that shows that their lowest herd is equal to our best herds at Tailevu. This indicates that we should go in for testing more extensively than has been done in the past. We have offered the suppliers an excellent scheme. It is costing them nothing. All they

have to do is to take the samples and bring them to the factory where they will be tested free of charge. I have written to the Department of Agriculture in New Zealand, and the Director of the Dairy Division asking for all available information in connection with testing. When received this will be at the disposal of the farmers. Another point was raised this morning which I personally think is a good scheme. When I was in New Zealand I showed Dr. Thompson's Regulations to one of the prominent men in the dairy industry there and the only fault he could find with them was that they were not strong enough. Of course, they can be amended and brought up-to-date. The appointment of a Dairy Instructor is essential and it would assist the farmers in this way. It would be one of his jobs, if we were making second-grade butter, to go to the farmer and put him right. It might be his separator at fault. I tested a man's separator last week and I found that he was losing at the rate of £7 per month. No one in the dairying industry in Fiji can afford to lose £7 per month. It is unfortunate that some of the suppliers think the time is not yet ripe for the appointment of a Dairy Instructor. At the present time we are producing more butter than the local market can consume and if we want to compete with other countries we have to put a decent article on the market. It is no use our going ahead and sending away second-grade butter and trying to sell it against New Zealand butter which is equal to the Danish article. I think these matters should be gone into and the farmers should agree as a body to employ highly skilled men which will pay them in the long run.

Mr. Turbet.—In my opinion the cows supplying milk for local consumption do not compare with those supplying butter-fat because the land in the immediate vicinity of Suva does not appear to be suitable for pasturage. It would be much better if these dairies were moved from Suva into the country, say the Rewa valley.

Mr. Ginn.—I take it I am the largest individual supplier in Suva. I represent the Suva Milk Supply Company. I have sold milk for many years and I claim that the test of my milk is equal to the test of specially selected Jersey cows. My only difficulty is to get the quantity of milk. I am quite satisfied with the quality.

Mr. Hunt.—When dairy farming in Tailevu I found that 2·45 gallons of milk were required to make a pound of butter, whereas in Suva milk was sold for 6d. a quart. The Tailevu settlers are on a better wicket than the Rewa suppliers because the former place only required 2·45 gallons of milk per pound of butter, whereas the latter required 2·85 gallons.

His Excellency the Governor.—It may be that an example of hand-feeding which came under my personal notice in Hong Kong will be of interest. One large dairy there with several hundreds of head of cattle depended entirely on hand feeding. There was no pasturage at all and the cattle were only turned loose for exercise.

Mr. Barnes.—Summarising some of the salient points of Mr. Stuchbery's paper, together with those introduced by Mr. Turbet and those which have been brought forward by the members in the body of the hall, I am pleased to see the keen interest that has been taken and the very useful information that has come to light in the course of discussion. The main points of Mr. Stuchbery's paper are that the dairy industry is now firmly established as an agricultural industry of Fiji, that it has grown in seven or eight years to take its place among the more important agricultural industries, but there still remains much to be done. It has been admitted that we do not know sufficient about the feeding requirements of our animals. The

present discussion will be of great help to the Department, indicating as it does the lines of inquiry to be followed. We must all combine and work in close co-operation for the improvement of this important industry to the Colony.

His Excellency the Governor.—The next paper to be read is on the subject of Coconut Oil and Copra by Mr. Barnes.

COCONUT OIL AND COPRA.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E., Superintendent of Agriculture.

Vegetable Oils.—Vegetable oils are amongst the most interesting and valuable substances produced by plant life. Oil is found in the fruit, flowers, leaves and stems of many plants and the oils themselves are as diverse in characteristics and uses as the plants from which they are obtained. Some of the oils, known as volatile or essential oils, find a use in the manufacture of perfumery and flavouring essences. Others provide valuable human and animal food and still more find employment in the manufacture of soap and in the paint and varnish industries.

Coconut Oil.—From the point of view of the Colony of Fiji, the most important vegetable oil is coconut oil produced from copra, with which we are all familiar. Coconut oil is a vegetable fat and belongs to the non-volatile class of vegetable oils, or as they are sometimes known, fixed oils. They are used in both the edible oil and the soap industries. Coconut oil essentially consists of a combination of certain so-called fatty acids with glycerine in the forms chemically known as glycerines.

Fatty Acids.—The fatty acids themselves are interesting chemical compounds, ranging from formic acid, commonly occurring in the animal world as the irritant liquid secreted by ants, bees, wasps, and in the vegetable world occurring in the common nettle and other stinging plants. The next in that series * is acetic acid, familiar on the table in the form of a diluted solution known as vinegar. Much higher up in the series we come to palmitic acid which is a white solid at ordinary temperatures and is largely used in the manufacture of candles. Palmitic acid occurs combined with glycerine in many vegetable oils, but principally in palm oil which is the produce of the oil palm (*Elaeis guineensis*) examples of which will be found in the Botanical Gardens, Suva. Glycerine is a substance with which we are all familiar. It is a heavy water white liquid used largely in the explosive industry and in medicine. Glycerine to a large extent influences the market price of vegetable oils during war time owing to its use in the manufacture of high explosives.

Alcohols.—Glycerine is a member of the alcohol series of compounds and is distantly related to the commonly occurring ethyl alcohol which we know in potable liquors like whisky, gin, brandy, &c. Alcohols are capable of combining with fatty acids to form substances known as esters. Thus, for example, amyl acetate, a pleasant smelling liquid, is formed by the union of amyl alcohol and acetic acid. This may be familiar to some of us by reason of the fact that it is largely used as a cement for celluloid. In these cases one molecule of the alcohol is capable of combining with one molecule of the acid because the alcohol has only one hydroxyl radical. Ethyl alcohol and amyl alcohol are monohydric alcohols. Glycerine, or to give it its correct name, glycerol, is a trihydric alcohol, that is, it has three hydroxyl radicals and is capable of union with three molecules of

* Actually there are five distinct series of fatty acids.

fatty acid. The resulting compound is known as a triglyceride. It has already been mentioned that when the union of an alcohol with a fatty acid takes place water is eliminated. Conversely the addition of water by special means to the ester or the compound of the acid and alcohol will split it up yielding as a result the original alcohol and acid as separate substances. This process, the breaking down of an ester into its component parts, is known as hydrolysis and is of great importance in connection with vegetable oils. It is in fact the basis of the soap industry.

Coconut oil, as we know it, is a clear pale yellowish liquid which will, however, solidify if the temperature falls below 24·5° C. Although it is a stable compound,* that is, a compound which is not easily broken down into its constituent parts, it is, nevertheless, susceptible to the action of chemicals and ferments, which break it down into fatty acids on the one hand and glycerine on the other. The process of hydrolysis, which is in effect, the addition of the elements of water to the oil, followed by the subsequent breaking up of the compound into the two parts already mentioned can be carried out quite readily. It is this comparative ease with which certain vegetable oils can be decomposed that renders it so necessary to prepare the raw material from which the oil is obtained with the greatest possible degree of care, always having in mind the exclusion of those factors which will tend to break down the oil and so reduce its market value.

Coconut oil in its pure state is neutral, that is to say, the whole of the fatty acids are in a state of combination with glycerine and the manufacturer of edible oil requires that the raw material, that is, the copra from which oil is expressed shall yield products as nearly neutral as possible. The soap manufacturer, however, is not so particular, more especially at the present time when glycerine is a drug on the market. What he requires are fatty acids which he can saponify by treatment with alkalis to form soap. In its natural state in copra the oil is much more readily decomposed than after it has been extracted by expression of the dried kernel of the coconut. From the time when the nut is first split until the dried copra reaches the oil mill it is liable to progressive decomposition if not carefully handled at every stage of its preparation and transport.

Decomposition of vegetable oils.—In certain vegetable oil bearing fruits such as the fruit of the oil palm the agencies which effect the decomposition of the oil are actually present in the fruit. Palm oil as it occurs in undamaged fresh fruit of the tree is neutral, but as soon as the fruit is bruised the oil cells in the vicinity of the bruise are ruptured and the oil comes in contact with what is known as an enzyme, which is the active principle of a ferment, and is immediately hydrolysed or transformed, by addition of the elements of water, into fatty acids and glycerine in their uncombined states. In the case of copra no such agency is present in the kernel and such decomposition of the oil as occurs is invariably the result of some introduced condition caused by careless handling and manufacture of the copra or exposure of the copra to the actions of enzymes or ferments from other sources. Apart from the disruptive action, as we may call it, of these enzymes water itself without any other assistance will very slowly cause the decomposition of certain vegetable oils. The presence of water is actually an absolute necessity for the process of hydrolysis to go on. This process, however, is greatly accelerated by the presence of the agencies already referred to, known as enzymes.

Effect of Moulds.—The common moulds which so readily grow on the surface of copra under damp conditions are fruitful sources of fat-splitting

* More correctly a mixture of compounds as it is a mixture of glycerides of several fatty acids.

enzymes. The damp surface of green copra forms an ideal developing ground for the innumerable spores of moulds which occur in the air having been derived from mature mould growths. Although the moulds develop comparatively rapidly they do take an appreciable time to reach a stage where their products are capable of decomposing the oil and their action in the early stages is entirely superficial. If, however, the green copra* is left undried in heaps mould growths develop with great rapidity and the infection spreads throughout the whole mass which quickly becomes a stinking heap of decomposed oily vegetable matter.

Rancidity.—A secondary action occurs after the original hydrolysis has commenced, resulting in the condition known as rancidity. Rancidity and the presence of free fatty acids in vegetable oils are often confused and it should be understood that although the one is a consequence of the other there is no similarity between the products which give rise to the two conditions. Rancidity is the result of the subsequent breaking down of the fatty acids liberated by hydrolysis under the action of moisture and air. The products formed are objectionable in flavour and odour and often give rise to considerable trouble in purifying the oil subsequently expressed from the copra. Highly rancid copra cannot be satisfactorily used in the edible oil industry. It is thus clear that the preparation of copra of good quality involves the careful exclusion of all conditions which will encourage the hydrolysis of the soil and the development of rancidity. The only way to do this is to dry the freshly cut green copra as rapidly as possible either in the sun or in a properly constructed and effective artificial drier. Green copra when freshly cut contains some 65 per cent. of water which must be reduced as quickly as is compatible with good quality of copra to somewhere in the neighbourhood of 5 per cent. if the product is to be free from more than a trace of free fatty acid. Though sun drying under ideal conditions is the best method of preparing high grade copra such a quality of copra can be obtained by artificial methods.

Drying.—The removal of moisture from vegetable matter in order to give a satisfactory grade of resulting product is not, however, so simple a matter as it would appear. Temperature conditions must be very carefully controlled, for if the drying copra is overheated chemical changes take place in the meat and the result is an inferior grade of product. Under no circumstances should the temperature be allowed to exceed 70° C. (158°F.) in the early stages of the drying. Overheating in the early stages of copra drying results in case hardening and moisture from the interior of the meat is prevented from diffusing as rapidly as it should to the outside layers, so that the copra appears to be dry when actually it is not. Such copra deteriorates seriously during storage and the shrinkage is of course, very high. By shrinkage is meant the loss of weight caused by evaporation of moisture. To illustrate the effect of over-heating vegetable matter in order to dry it rapidly we may consider the case of cane sugar which as is well known caramelises and turns brown when heated to a certain temperature. Starches and proteins undergo decomposition under the influence of heat and green copra which contains all these substances may be badly affected from over-heating during drying. In the design of kilns and hot air driers it is therefore necessary carefully to consider the question of temperature control.

Rate of drying.—The rate of loss of moisture from the drying copra is only partially dependent upon the temperature. Other important factors are the humidity of the air passing through the drier or over the drying

* The term " green copra " is used to denote the fresh kernel of the mature coconut.

copra and the rate of movement of the air current. Artificial driers for copra are familiar to most of us in Fiji. They are of several types, but in all of them the object is the same, that is, the removal as rapidly and as efficiently as possible of the excess moisture from the green copra. Involved in the question of efficiency is the quantity of fuel required to dry a given weight of copra, and it is here that there is still ample opportunity for research. Cartage of fuel to the drier is an expensive matter and when the husks of the coconut have to be supplemented by cut wood fuel artificial drying becomes very costly.

Sun drying.—The best method of drying the kernel and preventing more than the minimum decomposition of the oil is by exposure to bright sunlight in the open air, and it is in this manner that highest grade copra is produced. It is, however, by no means always possible to rely on weather conditions satisfactory for sun-drying, with the result that many methods of artificial drying, so designed in some cases as to facilitate the change over from sun-drying to artificial drying have been devised. Rainy weather is the bugbear of the copra maker. The large plantation owner overcomes the difficulty by using driers such as the "Chula," supplied complete by an English firm, or large locally-constructed driers of various designs.

Simple kilns.—The small producer also feels the need of some artificial drying kiln, and solves his problem by building a simple and usually ineffective erection which turns out a very inferior grade of copra. For example, in Zanzibar the kiln often takes the form of a shallow pit 8 or 10 feet wide, over which is erected a crude platform of branches and sticks. The kernels to be dried are piled on the top, and a fire started in the pit, the fuel being the husks of the coconuts. The product is black, insufficiently dried, and evil-smelling, and is quite unsuitable as a source of edible oil. It deteriorates seriously during storage and transport and commands but a low market price. An improved form of this type of kiln is in use, consisting of a low rectangular wall with a door at each end. The wall supports a framework of wood or iron rails which carries expanded metal or sticks and wire netting. This forms the platform on which the drying copra rests. The whole is covered by a thatched roof to keep out rain. Drying is effected by a small fire fed from each end of the large chamber under the platform, and hot air, mixed with the products of combustion, passes through the "kernels," which, though thoroughly dried, assume a dark-brown colour.

The objection to any kiln of this type is that the product is blackened by the smoke from the fire, and it is obvious that it is necessary to prevent access of the smoke to the drying material if the product is to be of good appearance. This can be effected with the kiln last described by making the platform of corrugated-iron sheets covered with clean sand, and by carrying off the smoke by a flue leading to a chimney near one end of the chamber. A simpler form of effective "sand-bath" drier consists of a channel excavated in the ground, with one end arranged as a fireplace and the other leading to a chimney, the channel being covered with sheets of corrugated-iron with sand on the top. The fireplace is closed in at the top by a layer of earth suitably supported, and the whole covered by a thatched roof. A number of such channels can be arranged radially around a central chimney. In situations where the nature of the soil is unsuitable for this underground-flue type, a similar effect can be achieved by building two, four, or eight chambers above ground, with flues leading to a common chimney, iron sheets covered with sand being used as before for the drying platform.

The three kinds of " sand-bath " drier described are under observation on one of the Government plantations in Zanzibar Island. They will effectively dry coconut kernels in 36 to 48 hours, the copra being of excellent appearance and practically indistinguishable from the best local sun-dried product.

DETAILS OF " SAND-BATH " TYPE COPRA DRIERS.

	Area of drying Platform Sq. ft.	*Capacity Kernels**	*Cost of erection.*
1. Large chamber type	140	700	£15
2. Underground flue type	138	700	8
3. Small chamber type	135 (2 platforms)	700	8

* Kernels in shell. After a few hours drying the kernels are removed from the half-shells and dried on the same kiln. Kernels from 700 nuts make about 230 lb dry copra.

From the brief description and statement of costs of erection, it will be seen that these kilns are suited to the needs of the small producer. For this class of user, it is essential that the type of kiln adopted should be inexpensive and capable of construction from material available locally.

Design of driers.—In proportion to the amount of copra dried the quantity of fuel required is large. Such kilns or driers would not be suitable for the requirements of the large scale producer of copra. With larger installations it is essential to ensure that the design provides for the proper and effective circulation of warm air throughout the drying material. Of the two types, that is, the one in which the copra is placed in the drier in bulk and the other in which trays are used to carry the copra in comparatively shallow layers, the latter is preferable. In the former case although hot air can be drawn or forced through most of the copra it is inevitable that the air will pass through particular channels and that where the material is closely massed together a baking effect rather than an air drying effect will be exercised. With properly constructed tray driers continuous and regular circulation of warm air over the whole surface of drying material can be assured with the result that a uniform product is obtained.

In many districts in Fiji the usual type of " running vata " could be modified with advantage to provide for hot air drying during wet weather, and to speed up drying by working at night during busy periods. The normal construction would need to be altered somewhat, but the additional expense involved should not be great. The sides and ends would require to be fitted with shutters which could be opened and closed at will in such a manner as to permit of the movement of the trays. Heating would be provided by a furnace set low at one end having one or more wide section flues passing underneath the lowest range of trays, well clear of ground level, to a smoke box and chimney at the other end. Ventilators would be fitted in the roof and the trays so arranged that effective circulation of warm air over the copra was assured. When in use as an artificial drier the lowest shutters only would be opened. Natural draught would draw in cold air from outside which would be heated by the flues, and traversing the trays of copra, would pass out through the ventilators. The general scheme is illustrated by the diagram.

Economic factors.—There is no doubt that the quality of copra shipped from Fiji is capable of considerable improvement with a consequent enhancement of its market value. The main factor affecting the value of copra is its oil content. Next in order comes the free fatty acid content, which determines to a great extent the particular industry in which the oil will be

utilised. The most important aspect of copra preparation is the effective removal of water. This controls the ultimate oil content of the product and, to a very large extent, the quality of the oil obtained from it. The exclusion of foreign materials is also important.

The solution of the difficulties facing producers in Fiji is largely in their own hands, but merchants and Government must assist by ensuring that copra of good quality is purchased and shipped as such and not mixed indiscriminately with low grade material. Fiji can produce copra of good quality and if the best grades of copra realised their market value, undoubtedly would do so. The introduction of grading would be of great help to the producers as they would thereby receive a fair market price for their product. Reference to the reports by the Imperial Institute, London, (Appendix of this paper) shows that copra of good quality, dry, and of low free acid content is worth from 10s. to 15s. per ton more than the low grade material of approximately the same moisture content.

At present the copra market is depressed and producers are discouraged. The industry in this Colony is poorly organised. Production costs are high, transport is expensive, and the general standard of quality very low. The modern cry is for "rationalization" of industry. Our copra industry needs such organisation in the direction of increased production, lower costs of preparation, handling, transport and marketing, and improved quality of our product. By directing our energies along these lines we should be able greatly to improve the position of the copra producers of the Colony.

APPENDIX.

IMPERIAL INSTITUTE,
LONDON, S.W. 7

REPORT ON COPRA FROM ZANZIBAR.

The samples of copra which are the subject of this report were forwarded to the Imperial Institute by the Assistant Director of Agriculture and are referred to in his letter No. A.D. 1181/28 of the 5th November, 1928. The samples were stated to represent four grades of copra produced in Zanzibar, and it was desired to ascertain their quality and market value. Nos. 1, 2 and 3 had been produced on Government plantations whilst No. 4 had been purchased from a merchant and represented the normal product of the native and Indian copra producers.

DESCRIPTION.

No. 1 *Sun Dried.*—Weight, 5 cwt. 85 lb. Bold copra of fairly good appearance, in the form of large pieces, mostly half-nuts. The inner surface was mostly very pale and internally the copra was free from discolouration. Many of the pieces were covered with green mould.

No. 2 *Kiln Dried.*—"Artificially dried on a kiln constructed of corrugated iron covered with a layer of sand, with a fireplace and flue underneath." Weight, 6 cwt. Pieces of copra very similar in appearance to the above sample No. 1, but on the whole of rather better colour and less frequently covered with mould.

No. 3 *Smoke Dried.*—"Prepared by drying on a platform constructed of iron rails and expanded metal over a large chamber with a fire door at each end. Coconut husks were burnt in the chamber and the products of combustion passed through the drying kernels." Weight, 5 cwt. 53 lb. Large pieces of copra (mostly half-nuts) of fair appearance, but in many cases covered with mould. The inner surface varied in colour from very pale brown to reddish-brown. Internally the copra was mostly free from discolouration. The sample had been slightly attacked by insects.

No. 4 *Fair Average Zanzibar Quality.*—Weight, 6 cwt. 27 lb. This sample consisted partly of half-nuts, but mostly of small pieces and dust. The copra was dirty and of very poor appearance, and was slightly attacked by insects. The inner surface of the pieces varied from brown to very dark brown, being chiefly dark brown, and was also mouldy. Internally most of the pieces showed discolouration for part of the thickness.

Results of Examination.—The samples were examined with the following results:—

	No. 1. Sun-dried.	No. 2. Kiln-dried.	No. 3. Smoke-dried.	No. 4. Fair average Zanzibar quality.
Moisture per cent	4·1	4·1	3·8	3·3
Oil in copra as received per cent	67·4	65·7	67·8	69·6
Oil in moisture free copra per cent	70·3	68·5	70·5	72·0
Acid value of extracted oil .	0·7	1·0	0·8	24·6
Free fatty acids (as lauric acid) in extracted oil. per cent	0·25	0·36	0·29	8·78

The oils as extracted from the copras with light petroleum were in general of normal appearance, but those from samples Nos. 3 and 4 had a yellowish tint.

The foregoing results show that the four samples all contained normal amounts of moisture, whilst the yields of oil compare favourably with the figure of 66 per cent. regarded as the minimum desirable for copra of good merchantable quality. Sample No. 4 (Fair Average Quality) contained the largest percentage of oil and No. 2 (Kiln-dried) the least.

The acidity of the extracted oils was very satisfactory in all cases with the exception of sample No. 4, the oil from which contained a high percentage of free fatty acids.

The three experimental samples, Nos. 1, 2 and 3 were all much better than the commercial sample No. 4 as regards both appearance and the acidity of the extracted oil. There was not much difference between the sun-dried sample No. 1 in appearance, but the former contained rather more oil which was of slightly better colour.

Commercial Value.—The samples were submitted to a firm of copra brokers in London, who furnished the following report:—

No. 1.—An exceptionally good delivery of F.M.S. Zanzibar, containing a few pieces slightly affected by mould and having the appearance of having been slightly overdried.

No. 2.—A very good delivery of Zanzibar copra, being clear and white in appearance. Would compare very favourably with Sample No. 1, with the difference that it seems to be hot air dried.

No. 3.—A good delivery of selected smoke-dried Zanzibar copra of particularly white and clean appearance.

No. 4.—A poor delivery of F.M. Zanzibar, of dirty appearance, and containing too much dust and small pieces.

The firm also made the following observations on the value of the samples and the market for Zanzibar copra:—

The appearance of samples Nos. 1 and 2 was very similar, except that No. 2 was a little whiter than No. 1. Both these samples were extremely good copra and very much superior to what is generally expected of Fair Merchantable Sun-dried Zanzibar. No. 3 was a very good smoke-dried copra and much superior to what is generally expected of this grade. Sample No. 4 had the appearance of ordinary Fair Merchantable Zanzibar which we are accustomed to seeing, except that it was of rather inferior quality, and a small allowance would have been given on same if arbitration had been claimed.

We notice that samples Nos. 1, 2 and 3 were produced on Government plantations, and no doubt this accounts for the greatly improved appearance and quality. We are perfectly sure that if the cost of producing copra up to this standard is not a great deal more, the producer would obtain a better price if the buyers were sure that they were going to get a good grade of copra, as per these samples. Zanzibar copra has always been known by the high contents of oil, but it has always been a very irregular description as compared with other qualities, owing to the variable weather, and very often Zanzibar copra, when it has been left out to dry, has got damp and this has caused it to become decomposed and dark in colour, this affecting the quality of the oil.

During the last year or so the best market for Zanzibar copra has been Genoa, where one or two crushers have been prepared to pay considerably better prices than anywhere else. These Italian buyers have used it, as far as we are aware, chiefly for soap-making, and therefore we rather doubt whether they would pay an extra premium for obtaining a higher grade quality, but to other ports, such as Marseilles, London, Rotterdam or Hamburg, where this copra is occasionally sold, the buyers would probably pay for samples Nos. 1 and 2 fully 10s. to 15s. per ton more than is usually obtained for ordinary Fair Merchantable Sun-dried Zanzibar, and 5s. to 10s. per ton more for sample No. 3 than is usually paid for Fair Merchantable Zanzibar; but it would be necessary first to let the various buyers (of whom there are a fair number) have samples of these grades, and also they might wish us to give some guarantee that any shipments made would be up to the standard of these samples.

The nominal value to-day of Fair Merchantable Sun-dried Zanzibar for April-May shipment to London, Rotterdam, Hamburg or Marseilles is about £22 15s. and that of Fair Merchantable Zanzibar £22 5s. per ton, but the Italian buyers would probably pay about 10s. per ton more to Genoa. We repeat ourselves in saying that to the first named ports we could probably obtain 10s. to 15s. above these figures for the present samples.

The market for copra has steadily declined during the past year, owing to the heavy shipments of copra generally from all producing countries, and at the present time is in a very dull state.

Remarks.—The results of this investigation show that the quality of Zanzibar copra could be considerably improved by more careful drying either in the sun or in kilns. The smoke-dried sample No. 3, although superior to the commercial product represented by No. 4, was inferior to the sun-dried and kiln-dried samples Nos. 1 and 2.

In the opinion of the brokers, copra similar to samples Nos. 1 and 2 would probably realise 10s. to 15s. per ton more than the ordinary fair average quality and No. 3, 5s. to 10s. per ton more. If these increased values are sufficient to render preparation by the improved methods remunerative, it would be advisable, when commercial quantities are available, to adopt the brokers' suggestion and forward large samples to the Imperial Institute for distribution to possible purchasers.

28th March, 1929.

His Excellency the Governor.—Mr. Kermack is unfortunately ill and unable to attend the conference. I will ask Mr. Barnes to read the paper on Banana Cultivation in Fiji.

FRUIT PRODUCTION FOR EXPORT—PART II,—CULTIVATION OF THE BANANA IN FIJI.

By JAMES KERMACK, Assistant Superintendent of Agriculture and Inspector of Produce.

Introduction.—The main object of this paper is to offer for consideration a few simple yet effective methods of cultivation which might readily be adopted in Fiji, where banana growing is now entirely in the hands of natives, whose system of planting and cultivating is generally speaking, primitive and crude in the extreme. Before, however, any suggestions are made, it might be well that a brief history be given of the industry in the Colony since 1914, when production of fruit reached its peak with shipments during that year, amounting to 1,715,766 bunches, equivalent to approximately 858,000 cases.

History of industry.—On the island of Vitilevu in districts where transportation is convenient and where probably soil and climatic conditions are more favourable to the production of first-class fruit than elsewhere in the Group, the banana industry in 1914 assumed considerable proportions and was more or less controlled by Europeans who by systematic cultivation, produced sufficient fruit of exceptionally fine quality to supply the demands of the Sydney, Australia, and Auckland, New Zealand, markets. A decrease of 700,000 bunches in 1915 due to a severe windstorm and floods in the latter part of 1914 apparently had not a depressing effect on the industry, as in the following year, production increased to within 65,000 of the record shipment of 1914. Unfortunately, the reactionary period was short lived and in 1917 effects of the introduction into or the development in the Colony of a fungus disease *Cercospora* locally termed " Sigatoka" the name of the district where it was first detected in Fiji, which attacked the leaves and in a short space of time defoliated the tree, were only too obvious through a considerable decrease in production of fruit during that year. Operating concurrently with the leaf spot *Cercospora* disease were " Bunchy top " (*Pentolonia negronervosa*), a virus transmitted by a small insect the banana aphis, the banana weevil borer (*Cosmopolites sordidus*),

the most serious insect pest affecting the banana plant in Fiji and "Banana Scab," the result of a deposit of larvae of a small moth which disfigures the skin of the fruit in its early stage, and experiments were immediately made by the Department of Agriculture in an attempt to control these different diseases and pest troubles by spraying and the introduction of parasites, but little or no success was met with. It is therefore not surprising that production of fruit in 1919 should drop to 614,722 bunches which is the normal requirement of the Auckland, New Zealand, market. In 1921, what amounted to an embargo on Fiji bananas through the imposition of a duty of one penny per lb by the Australian Commonwealth Government, shipments to that country were, with the exception of small consignments from time to time, discontinued, shippers considering that the high tariff precluded the possibility of a profitable market. New Zealand, the only other nearby available market, still offered possibilities but the limited quantity of fruit which a comparatively small population could absorb was evidently not sufficient for Europeans continuing operations and gradually their cultivations through neglect, possibly due to the high cost of necessary labour, were abandoned, leaving natives who had all along been associated with the industry, in the growing of small patches of bananas in conjunction with yams, dalo, &c., in their village provision grounds, sole producers. Banana growing with the average native, however, had been and to a great extent still remains a secondary consideration to the production of his staple food, yams and dalo, and whilst he probably realises vaguely that it means for him a source of revenue each month throughout the year, he does not look upon it from a commercial viewpoint, neglecting as he does the irregularly planted patches as soon as his provision crop is harvested. A steady decline in fruit production since 1921 was viewed with considerable alarm in 1927, and with the object of placing the industry on a better footing and to ensure a regular monthly shipment of from 20,000 to 25,000 cases to Auckland, a cleaning up of native plantations campaign was instituted by the Agricultural Department, the work, under the supervision of European Field Inspectors, who were appointed by the Government under the Diseases of Plants Ordinance, to be undertaken by natives at such times throughout the year as would not conflict with their communal operations. A degree of success was claimed in the initial stages, but it was latterly found that many, if not most of the fields were so badly infected with leaf spot disease and infected with the banana borer weevil that in order to save the industry a general planting up by natives of new areas was necessary. Additional Inspectors were appointed in 1928 and with the object of developing areas sufficiently large to ensure at least an export of the quantity of fruit already stated operations in the latter part of that year were commenced in the Wainimala, Wainibuka and Waidina districts on the island of Vitilevu, where it was considered stretches of rich alluvial river flats, isolated from old cultivations still existed. To date slight progress only has been made, approximately 330 acres having been planted with suckers which were carefully selected and examined by Inspectors for borer infection and whilst it is gratifying to know that the new fields which are gradually coming into bearing are yielding sound, marketable fruit, it is now realised from the fact fruit production during 1929 reached a low level of 185,000 cases or 370,000 bunches and falling short by some 80,000 cases of the minimum requirement of the Auckland market, that if a more active course of planting, systematic cleaning and pruning and draining of the land where necessary, is not adopted there is a grave danger that a valuable though comparatively small industry will be lost to the Colony.

SUGGESTIONS FOR IMPROVED METHODS OF CULTIVATION AND HARVESTING AND TRANSPORTING OF FRUIT FOR EXPORT.

Selection of Land.—Selection of land which is near to convenient water or roadway transportation should be a first consideration of the prospective planter provided the soil is suitable. The nature of the soil can be more or less determined by its general appearance and as most agriculturists are or should be able to discriminate between poor and rich soils there is small necessity for a chemical analysis being made. The banana will grow on a great variety of soils, but apart from the rich alluvial river flats where the soil is ideal perhaps the best soil for its culture is a deep loam composed principally of sand and clay, and containing a good proportion of lime and humus. Humus, otherwise decayed vegetable matter, is highly essential to all plant life, probably more especially to the banana, through its supply of nitrogen. Care should be taken that the area selected for planting is well protected from high winds which tear and wither the leaves, thereby retarding the growth of the plant and for this reason steep hillsides on the weather side should, if possible, be avoided.

Preparation of Land.—Land should be prepared during the dry season and immediately prior to spring, which is the planting season. Clearing operations are comparatively easy during that period, but the tendency for convenience to burn the cut grass and bush should, unless it is extremely light, be discouraged, as by heavy firing a considerable portion of plant food may be lost through the destruction of the surface humus in the soil. Where practicable all grass should be dug into the soil, otherwise it should, along with the cleared bush, be removed to a place outside the area to be planted, and burned Alignment of the field should be undertaken immediately clearing operations are completed, spacing the distances where the plants are to be placed not less than 12 feet apart, but preferably 15 feet, which allows for proper ventilation or air current, convenient cultivation of the land and ample room for the development of the banana roots which require a radius of from six to eight feet. Holes should then be dug where the suckers are to be planted, the depth of the hole varying with the conditions of the soil. In heavy soils a depth of 2½ feet with a corresponding width should be considered, filling in with loose surface soil. This will permit of the roots getting a good start without having to unduly force their way, and the plant becoming thoroughly established in its bed in a comparatively short time. In free soil a shallower depth of, say, 1½ to 2 feet would be sufficient.

Drainage.—Whilst an abundant rainfall is necessary to the satisfactory growth of the banana, good drainage is highly essential and it should be one of the first considerations of the planter to see that where there is a surplus of water in the soil, a system of drains is undertaken prior to the planting of his field. By doing so danger of the soil becoming waterlogged and air passages thereby blocked will be prevented. Where soil is light and porous drainage should be limited, as there is always a danger of making the soil too dry by overdraining. It must always be borne in mind that the principal object of drainage is to prevent stagnation of water in the soil. The method of drainage usually adopted in banana fields is by trenching to a depth of from three to four feet at distances varying from 30 to 60 feet apart, according to the nature of the soil. Sump drainage however, where the subsoil is of a porous character, could be economically undertaken and be quite effective by digging holes say four feet in width to a depth that would reach the porous strata in different places throughout the area. The sump system where practicable commends itself as no

subsequent attention is necessary, as would be the case with trenches, which require periodical clearing of fallen banana trees, leaves and other vegetable matter.

Planting.—Spring is the natural time of the year for planting, although operations may be continued during the early part of summer with a degree of success provided there is sufficient, but not excessive, rainfall. Every attention should be given to the selection of suckers which should be taken from plants which show vigorous and healthy growth. Great care should also be exercised when removing suckers, which should have about six months' growth, from parent plants. In the absence of the proper type of tool for this purpose, a cane knife is invariably used, but such method is inadvisable, as there is always a danger of injury being done to other suckers by what is termed " bleeding " or wounding by cutting which would retard growth and probably affect fruiting. The proper tool to use is a narrow semi-circular spade with which it is possible to sever the sucker with little or no risk of damage in the operation. After a sucker has been removed the roots should be trimmed, as also eyes cut off with the exception of one which would appear to be the strongest. It should then be cut to within six inches of the bulb and planted with the eye five or six inches below the surface.

Cultivation after Planting.—Fields should be kept entirely free of weeds and on this account considerable labour is usually expended by the planter in cleaning, either by hoe or plough. A method, however, which not only obviates to a great extent the necessity of weeding but also is a means of conserving moisture in the soil is mulching. Dry grass is effectively used in different countries where the soil is dry and rainfall low, but this form of mulching does not altogether commend itself where insect pests abound, as decaying vegetable matter spread over the surface of the soil might harbour them. The planter should have in mind the danger of the banana borer weevil in this connection. A system of green mulching or green manuring is generally accepted as a most economic means of controlling weeds and at the same time enriching the soil. Mauritius or any other beans might be planted immediately the land is cleared and would effectively act as a cover crop until cut down after seeding, when they should be forked or ploughed into the soil close to the plant during the dry season, when the soil is in a condition to be worked. By continuous and systematic cultivation, bananas in suitable soil should give good returns for a number of years. A field with plants, say, 15 feet apart or approximately 200 to the acre when properly cultivated should yield anywhere from 250 to 300 bunches per acre, 75 per cent. of which should be nine hands or over.

Pruning of Plants.—Pruning is one of the most important operations in banana culture and should be undertaken when the plant is young. Too many suckers attached to the root must necessarily rob the parent of a certain amount of food and for this reason it is desirable that a limited number should be allowed to grow and in time produce fruit. It will therefore be understood that the object of pruning is to conserve the vigour of the plant which is to produce the first fruit and at the same time assist the growth of its followers, which will eventually take the place of the former after the fruit has been reaped. Not more than three suckers, although two is more advisable, should be left to follow the fruiting plant, if possible at equal distances around the bulb. The suckers left as followers should be at different stages of development in order that no two plants will be fruiting at the same time. By this system consecutive bunches of first-class fruit may reasonably be anticipated. The method of detaching suckers

from the parent plant has already been dealt with in this paper, but it may be well to again recommend care in the operation. When digging out suckers it is important that they should be severed completely from the bulb or corm as otherwise they will spring again in a quick space of time which would necessitate the pruning operation being repeated.

Diseases and Pests.—No effective means have yet been discovered whereby the different pests and diseases of bananas in Fiji can be controlled, but it is considered they may be minimised by keeping fields free of all fallen leaves, cut banana stems and any other decaying vegetable matter which might act as harbours. In the case of the scab moth a certain degree of success has been obtained in combating this trouble by dusting the flower of the banana immediately it shoots with Pyrethrum powder and planters should realise that by daily attention to the plants this method of treatment will save at least 75 per cent. of the fruit produced. Another pest, the banana borer, may be trapped in large quantities by cutting up pieces of banana stems and placing them at different intervals around and near to the plant. A tour of inspection should be made every morning to collect the beetles which invariably will be found under the freshly cut stem which is particularly attractive to them.

Harvesting and Marketing of Fruit.—Under favourable conditions the banana fruits in 10 to 12 months from the time of planting. A period of from three to four months is required for the development of the fruit to a stage at which it may be harvested. The proper grade or size of fruit to harvest would all depend on the distance the place of production is from a market and over what period transportation would extend. Assuming that the period is ten days and that six days of that period is utilized in handling and transporting the fruit to a steamer, fruit three-quarters developed should be considered as it not only carries well but is of commercial size and marketable the year round. Fruit matures more rapidly in the moist warm months than during a dry cool spell and if shipments are not frequent, say, once every two weeks there may be considerable loss in the field through fruit becoming overfull, due to a sudden change in weather conditions from cool to warm. In order, therefore, that there be no undue loss through marketable fruit being left on the plants when there is an opportunity to ship, it is highly essential that sound judgment be used in selecting the fruit to cut. Fruit should be cut either the day it is to be packed or not earlier than the previous day. In the operation care should be taken not to bruise the fruit by careless and rough handling which may not show at the time but eventually would when it commences to ripen by going black. Careful handling makes all the difference to satisfactory carriage and subsequent sale of fruit. After being cut it should not be exposed to the direct rays of the sun, otherwise it will scorch or be affected in such a way that it will in a short time become soft and be unfit for the market. An open shed is an ideal shelter prior to packing, but this is not always practicable and dry banana leaves make an excellent substitute. Packing should be undertaken with the same amount of care as would be exercised in harvesting. Placing of fingers in the case which should be absolutely dry and clean is a highly important operation and this should receive the greatest attention. A loosely packed case is as hurtful to the fruit as one packed too tight. If the former method is adopted there is danger of skin disfigurement by rubbing of the fingers through transport vibration whilst the latter through undue pressure is likely to cause bruising. Transport from the field by punt, cutter or lorry of the cases containing fruit to the port of shipment should be done as expeditiously as possible,

but care must be taken that the cargo is not allowed to shift and be knocked about. When by punt or cutter which usually involves a long and sometimes tedious journey, good ventilation is necessary and to avoid cooking or excessive heating of the fruit sufficient air space by dunnaging between the rows of cases should be allowed. Protection against sun and rain must also be considered and an awning should always be in readiness should such be required. Loading on to the steamer is undertaken by the shipping company, and shippers should make it a point to see that the fruit is not roughly handled on the wharf and that it is conveyed to the vessel's hold in a careful manner.

Mr. MacDonald.—From my observations I conclude that the beetle introduced by Mr. Jepson is effectively controlling the weevil borer in some districts.

Mr. Faddy.—Some years ago we could not get a stand and I have planted a field five times. That was before the Jepson beetle arrived. Then we planted an area with 500 bananas and there was no trouble to get 100 per cent. established.

Conference adjourned at 3.50 p.m. until 10 a.m. on the 18th January, 1930.

Conference resumed at 10 a.m. on Saturday, 18th January, 1930.

His Excellency the Governor.—The first paper to be read this morning is by Mr. Surridge, on the subject of Green Manuring.

GREEN MANURING.

By H. R. Surridge, A.R.C.Sc., (I), Agronomist, Coconut Committee.

Introductory.—The object of this paper is to attract and stimulate interest amongst the various planters in these islands, in the very sound and inexpensive agricultural practice of green manuring. For this purpose the subject has been treated simply, so that planters who are interested and wish to know more of the matter may obtain further knowledge and help, first on application to their Department of Agriculture in Suva, and where interest is exceptionally keen, by a study of various books, *e.g.*, Halls *Fertilisers and Manures*, de Sorney's *Green Manures and Manuring in the Tropics*, *The Tropical Agriculturist* Vol. LXXIII No. 3, Sept., 1929, and others. That the practice advocated in this paper is essential is demonstrated by the world-wide scarcity of farm yard manure and the need for satisfying the soil's demand for humus, and by the necessity for the application of more intensive methods of agriculture, particularly in those countries where land is restricted in quantity owing either to density of population or difficulties of transport.

Historical.—In the history of agricultural practice, green manuring has long held a prominent place, something of its value having been known to the Romans 2,000 years ago, and to the Chinese over 3,000 years ago, but it is only in recent years that a truer appreciation ot its uses and value have come to be known. The Romans noted that when corn succeeded their bean crop a much better yield resulted. The result of this observation was the regular inclusion of beans in their system of crop rotation. This practice became common throughout the greater part of Central Europe and eventually extended to England, but its value was not appreciated there until the 17th–18th Centuries. Agriculture in England up to the

early part of the 17th Century had made very little progress, but with the increasing importance of the wool industry, the changing dietary from fish to meat, of an increasing population, and the introduction from Europe of new types of farm crops, a more intensive system of agriculture was evolved, involving the more active use of green manures.

Up to about 1700 the usual crop rotation was wheat, oats or barley and fallow, but Lord Townsend about this time endeavoured to grow, on his farm in Norfolk, turnips introduced from Belgium and Holland, and, after considerable difficulty, succeeded about 1725 in growing this root crop, thus adding one more crop to the farmer's rotation. But the fallow was still included in that rotation until experimentation demonstrated that with the introduction of another green manure crop (red clover in this case) not only could the new root crop be successfully grown, but owing to the soil rejuvenating qualities of the clover and bean crops, it was possible to dispense entirely with the fallow. This proved a most important innovation for the farmer because, first, it rendered all his land productive all the time, and second, that through this intensive cultivation he was able the more effectively to carry his live stock on through the winter with the additional feed obtained and thus cater for the increasing demand for meat and farm products. It was not until the 19th Century that investigation revealed how bean, clover or pea crops benefited the soil. Experiments carried out at Rothamsted about the middle of the 19th Century demonstrated that the nitrogen content of a soil was increased after a crop of bean or peas, irrespective of whether the bean or pea crop was harvested or not, it being the general custom to harvest the haulm and plough in the stubble. Subsequent experiments proved that if the haulm also was ploughed in, there was a still further increase in the nitrogen content of the soil. It was further found that this property was peculiar to plants belonging to the botanical order of the Leguminosae, with the result that since nitrogen is the most essential ingredient of plant food, as well as the most expensive of fertilisers to purchase, plants of this order have obtained precedence over other plants as green manuring crops.

Definition and uses.—Green manuring is the process of ploughing in various types of farm crops for the purpose of maintaining and increasing soil fertility. When considering green manuring three other important uses may be mentioned—

(1) as cover crops, to keep down weeding;
(2) for soil protection against erosion, particularly on undulating land and hill sides;
(3) as insect pest controls.

Humus.—Other possible uses will occur to the practical farmer to his ultimate benefit. Dealing first with the main purpose of increasing soil fertility, it is of interest to know something of how this is accomplished. One of the most important constituents of a fertile soil is humus. A lack of humus is invariably the sign of a poor soil. Humus is decaying organic and vegetable matter, and functions chiefly by—

(1) maintaining and increasing soil moisture;
(2) forming, in its decomposition, humic acid, which interacts with various soil materials, thereby releasing plant foodstuffs;
(3) supplying foodstuffs for various beneficial soil organisms, which in turn, assist in increasing the supply of plant foods in the soil;
(4) assisting in aerating the soil.

Leguminous Plants.—In closely-settled countries, up to recent times, farmyard manure was the main source of supply of humus, but with the

advent of the motor, this, the best of all manures, is not obtainable in sufficient quantity; especially is this so in the tropics, with the result that other sources of humus have had to be explored. The continual application of mineral manures without a sufficiency of humus, impoverishes the soil, so that circumstances have compelled the farmer to consider green manuring for its humus, as well as other elements of plant food that are required. In leguminious plants he found a substitute giving him a good supply of humus, and an appreciable amount of that most expensive and necessary of plant foods, nitrogen. An examination of the roots of these plants shows that they have a large number of nodules adhering. These nodules are colonies of bacteria which have the power of assimilating atmospheric nitrogen, and passing it on to the plant in a form which the plant can use for its own growth, and it is the result of this working together between the legume and the bacteria that ultimately results in an increased amount of nitrogen in the soil, whether the crop is ploughed in or not, in a form readily available to the succeeding crop. Experiment has demonstrated that more benefit results to the soil and the standing or succeeding crop when the leguminous crop is ploughed in just about flowering time, rather than running it on to seed.

Use as Green Manures.—Here in Fiji we have continually before us the advantage of green manuring on systematic lines, in the sugar-cane areas of the Colonial Sugar Refining Company Limited. This Company, by the application of green manuring, have not only maintained the fertility of their estates over a great number of years, but have in most instances increased that fertility, and, in other cases, turned and are turning the arid red lands, met with in some parts of these islands, into cane-growing areas through the systematic use of leguminous crops for green manuring. With such a practical demonstration of the benefit of green manuring before one, one wonders why the practice is not more general amongst the planters of these islands.

Coconut Plantations.—The copra industry, at present, is depressed, and there does not appear to be much hope for any marked increase in the market price of this commodity for some time to come, with the result that the producer must consider ways and means of reducing his costs and increasing his production per acre to counteract the loss of income produced by low prices. One method of assisting in attaining this desirable object, is to practice the art of green manuring on the plantations. It is reasonable to assume that the coconut will respond, as other farm crops do, to better feeding and cultivation, within limits. Being slow in its growth, in coming into bearing, and in maturing its foliage and fruit, suggests that a steady supply of plant food is essential for the proper development of the tree and its fruit. For this reason, the application of quick acting manures like nitrate of soda or sulphate of ammonia cannot be recommended, apart from their expense, rather the slow acting and cheap green manure, as supplied by a leguminous crop, seems to answer the necessary requirements. Compared with the artificial fertilisers just mentioned, green manures are slow in their action, and in their decomposition maintain a steady supply of the essential plant foods, nitrogen, of course, being the most important. Add to this the very efficient control such crops have over weeds, the additional humus when ploughed in, thus increasing the moisture content of the soil, particularly during dry spells—an important factor in maintaining an adequate food supply for the tree—and the result should be a reduction in weeding costs on the estate, a cheaper manure bill, the maintenance and probable enhancement of the soil fertility, and an improvement in the general health of the trees so that the yield should be increased.

Coconut Estate Practice.—Present day practice on coconut estates in these islands consists roughly of three kinds—

(1) neglect (mainly native plantations);
(2) weeded, either by hand or plough;
(3) the running of cattle under the trees in other words, these plantations are nominally under grass.

In the case of No. (1) this matter is being dealt with by the Coconut Inspectors who are instructing and encouraging the native to tend his copra plantation with method and intelligence.

Under No. (2) this practice has little to commend it. The ploughing in of weeds gives little, if anything, more than humus and it is extremely doubtful whether this practice pays for the labour involved.

With reference to No. (3) effective weed control is seldom established by cattle, as shown by the presence of lantana, "Koster's Curse," guava, &c., in many plantations running cattle amongst the trees, and it has yet to be proved that coconuts thrive to the best advantage when the ground is covered with grass.

In fruit orchards it is an established fact that in the presence of grass the trees are not so vigorous, the fruit smaller in size and of poorer quality though richer in colour than similar trees in a cultivated orchard. The two chief reasons for this are thought to be (1) presence of excess of carbonic acid gas in the soil, and (2) nitrogen starvation.

Dealing with (1), grass usually forms a dense covering of matted roots which prevent free circulation of air and water. These roots are continually exuding carbonic acid gas, a gas which, being heavier than air, gradually percolates down to the roots of the trees, inhibiting them in their function

In the case of (2), it is known that the nitrates in the soil occur within the top few inches, so that as this is produced either by rain or bacteria so the grass secures first claim on this important plant food, to the loss of the trees under which it is growing, hence a type of nitrogen starvation for the tree occurs. Such conditions apply to fruit plantations and it is to be expected that similar conditions operate in coconut plantations.

Effect of Leguminous Plants on Soil.—The effect of growing a leguminous crop is opposite to that of grass. Legumes ameliorate the soil by their root action, aerating it, making it much freer for working, and as already mentioned, increase the nitrogen content of the soil, so that the coconut tree stands to receive not only those nitrates naturally formed in the soil, or obtained from the air through the rain, but also those obtained and stored in the soil by the use of the leguminous crop. The result then should be to the advantage of the coconut, a result which planters in the Dutch East Indies, the Philippines and Malaya experience.

Soils.—As regards soils suitable for these green manuring crops, it may be generally stated that all coconut soils will produce leguminous crops. Undrained land does not favour the legume, neither does it favour coconuts, and sour land refuses to grow such crops until the acidity is corrected, the acidity restricting and destroying the activity of the essential bacteria, but application of lime, whether as lime or coral sand, or coral, will rectify this and enable such land to produce good leguminous crops. In these islands coral sand is generally obtainable at little expense.

Time for Ploughing in of Green Crops.—The time for cutting a green manure requires consideration. It is essential that the ground should be covered, particularly during the dry spell, so that if the legume is sown just before the wet season, it should, if an annual, mature towards the end of that season, allowing for some seed to be harvested, and some to be

ploughed in with the haulm to secure a volunteer crop to cover the ground during the dry spell. At the same time, it must be remembered that the maximum nitrogen content in such a crop occurs, as already mentioned, just about flowering time, so that local conditions of seed, manure and other requirements will control when the crop should be ploughed in.

Type of Legume Suitable.—The type of legume here considered is the herbaceous annual, *e.g.*, mauritius bean (*Stizilobium aterrimum*), rice bean (*Phaseolus calcoratus*) or cowpea (*Vigna*), these being the green manuring crops with which planters in Fiji are most familiar, particularly in and near the sugar-producing areas. The advantages of this type of legume are: (*a*) its manipulation requires the minimum of man power; (*b*) it covers the ground and controls the weeds rapidly; (*c*) it furnished supplies of food for man and beast if required; and (*d*) it produces on the average about five tons of green manure per acre with a fair supply of nitrogen. Where circumstances permit, an application of either coral sand or a combination of a phosphatic and potassic fertiliser would considerably enhance the value of the green manure.

Clover Sickness.—The bush type of legume, however, does not appear to be suitable for our local conditions; first, because hand labour is required to undertake the periodical prunings or loppings of these bushes, and second, because of the difficulty involved when it becomes necessary to eventually plough in this crop, since the stools of these bushes become very woody towards the end of their first season's growth. Such crops, being perennial in habit, would occupy the ground continuously for several years and by so doing, bring about that soil condition popularly known as "clover sickness." In the case of the herbaceous legume such a condition need not arise if two annual legumes are used on the plantation, for the changing of such legumes periodically, each occupying the other's ground, after say two or three volunteer crops have been ploughed in, would tend to prevent "clover sickness."

Varieties of Legumes Suitable.—I am indebted to the *Tropical Agriculturist*, Vol. LXXIII, No. 3, Sept., 1929, for a summary of those legumes in use in Ceylon, Malaya, the Philippines and Dutch East Indies, and below I give extracts of descriptions of those legumes which appear to be suitable for the conditions obtaining here in Fiji.

1. Peanut or Groundnut (*Arachis hypogœa*). Very useful as a green manure owing to its rapid growth. Suitable in dry districts. Good fodder. Not recommended as a catch crop owing to its attraction for rats.
2. Cowpeas (*Vigna catiang* or *V. sinensis*). Suitable for young and old plantations. Is a quick growing annual, forms excellent cover in 3–5 months, thrives on poor land and withstands drought and shade.
3. Mauritius bean (*Stizilobium atterimum, mucuna spp.*) Suitable for young and mature plantations and light shade. Is quick growing and when mixed with cowpea in proportion of 1 of cowpea to 4 of mauritius bean, a very quick and efficient ground cover is obtained.
4. *Rice bean* (*Phaseolus calcaratus*). An excellent bean, withstanding shade. Slow in getting away, but mixed with some cowpea the ground is quickly covered.

It would be necessary to experiment with the others mentioned in the list but not quoted here to observe their behaviour and suitability under the conditions prevailing in Fiji. Of those quoted, three as previously men-

tioned, are already in use on sugar estates and seed can, no doubt, be obtained by those planters who wish to do so, without difficulty.

To summarise, green manuring is an old established agricultural practice which has been proved to be of great value to many crops in many countries under varying conditions. For the coconut planter it offers a means whereby copra production can be increased at a very small expense, an expense which is offset by the saving of labour required for weeding. It furnishes a steady supply of humus, and an appreciable amount of nitrogenous plant food, thereby increasing the water-holding capacity of the soil and supplying a fair proportion of the most expensive of essential plant foods, nitrogen. Its practice has been shown to benefit plantations in Ceylon, the Philippines, Malaya and Dutch East Indies, and it is reasonable to expect that a like result will accrue here in Fiji if planters will adopt the use of legumes as green manuring crops.

Finally, while this paper has dealt more particularly with green manuring as applied to the coconut plantations, a similar result would be obtained if the practice was extended to other tropical crops, whether annual or perennial in character, *e.g.*, bananas, pawpaw, potatoes, &c.

His Excellency the Governor.—I congratulate Mr. Surridge on his paper. I have listened with the greatest interest to it. Green manuring is a subject with which I have had limited experience. Mr. Stockdale, who is now Agricultural Adviser at the Colonial Office, preached the doctrine of green manuring in Ceylon. It is a matter which has been closely gone into by the farmers in Ceylon particularly on tea, rubber and coconut plantations. Mr. Surridge has not dealt in detail with the valuable use of cover crops to prevent soil erosion. In Ceylon, where the hills run to 7,000 feet high, tea is planted on steep slopes and the humus is being washed down into the rivers and low country. I think this is a problem we will have to study in Fiji. My knowledge of the country is not very extensive at the present time, but we have heavy tropical rain and unless steps are taken by way of cover crops and terracing to prevent the soil getting washed away we shall find ourselves in a very precarious position.

Mr. Duncan.—I am doubtful as to the advisability of planting leguminous crops indiscriminately among the coconuts. In my experience it is preferable to run stock in the plantations, by which means the ground can be kept satisfactorily clean. A dense mass of vegetation, even if it were leguminous, would make it difficult to collect nuts and would preclude the grazing of cattle amongst the trees.

Mr. Surridge.—The main object of my paper is green manuring. The question as to whether any particular legume is beneficial for stock food would have to be gone into. There are two considerations, namely, the effect of the legume on the quality of the milk and also on the quality of the meat.

His Excellency the Governor.—With regard to cattle running on a coconut plantation, I know one of the largest planters in Ceylon whose plantation is one of the best I have seen. He is very particular about keeping down the noxious weeds and his cattle are a very valuable asset to him. I do not know whether it is the practice in Fiji to run cattle on coconut plantations.

Mr. Surridge.—With regard to the running of cattle on coconut plantations, I do not think that any progressive planter would be simply content to run cattle without making an effort to keep the noxious weeds, such as " Koster's Curse," Lantana and other pests down.

Mr. Barnes.—An important point in regard to use of leguminous plants in crop rotations, whereby the pernicious system of shifting cultivation,

so largely practised by natives in many parts of the world could be obviated, was not mentioned by Mr. Surridge. In Nigeria, East Africa and in parts of Fiji the native cultivator grows crops on a patch of land until yields fall off owing to the exhaustion of the soil. He then moves to another patch which he clears, plants and deserts in the same manner. These patches of deserted cultivation become rapidly covered with secondary bush and provide a splendid home for noxious weeds, thus becoming a source of infection for the areas around them. In Nigeria the Department of Agriculture has for some years experimented with systems of crop rotations, including the use of leguminous crops, to enable the natives to keep the same area of land in cultivation year after year. Such work is necessary here in Fiji, and Mr. Surridge's observations on the conditions of green manuring apply perfectly to the improvement of native systems of agriculture. In the issue of the *Agricultural Journal* for the last quarter of 1929 reference was made to an address of Mr. Stockdale, Agricultural Adviser at the Colonial Office, on the subject of soil erosion. This is a matter of vital importance to Fiji. We have excellent examples of the results of soil erosion in our river flats which consist entirely of soil eroded from the higher lands and brought down and deposited in the flats by the streams. Valuable as these river flats are, it must be borne in mind that the hillsides from which they have been derived have been denuded of soil and their capability of supporting vegetation thereby reduced. Examples of the wrong system of cultivating slopes are with us in Fiji. It is quite improper to plant on such land in the direction of the slope as soil erosion is thereby encouraged. Sloping land should be cultivated and planted parallel to the contour lines, that is at right angles to the line of the slope at any point, in order ultimately to secure a terraced effect, thus checking the washing away of the valuable surface soil. Here again the practice of green manuring is a valuable asset as surface washing can be largely checked if the ground is kept covered.

His Excellency the Governor.—I now ask Mr. Tarby to read a paper on Indian Agriculture in Fiji.

INDIAN AGRICULTURISTS' CONTRIBUTION TO THE AGRICULTURAL PRODUCTION OF THE COLONY.

By J. P. TARBY, Manager, Government Rice Mill.

IN respect to agriculture, Fiji may well boast of many assets and natural resources such as mild climate, dry and wet zones, fertile soils and abundant water-ways, &c. Perhaps, however, the foremost asset is the Indian agriculturists and their co-producers, the Indian labourers. Indeed, since it may now be assumed without fear of contradiction that the great majority of the present Indian population has made Fiji their permanent home and that their progeny can be counted upon also to remain here, the Indians may be likened to one of Fiji's natural resources. But, like all natural resources, unless utilised, they are, in respect to agriculture, of little economic importance, and unless properly and discreetly utilised, they cannot yield of their best. This is a maxim that should be applied to the Indian agriculturists and their co-workers, the Indian labourers. Conversely, as no natural resource can yield its worth or wealth of its own accord, that is, without organisation, direction and the outlay of some capital to exploit it, the Indian agriculturists cannot, more especially if expected to produce

in various directions, produce of their own initiative, that is, without tuition, direction and assistance (not necessarily in money) for their utilisation. This is another maxim that should be applied to the Indian agriculturists and their co-producers in Fiji. Strange to say the comparison of the Indian agricultural community to a natural resource has greater truth in it than at first meets the eye. Compare them for example, to the newly formed auriferous sandy deposits to be found in various parts of the world. Valuable, but hopelessly disunited, except by a common temporarily binding, but weak agency—water in the case of the sandy deposits and nationality in that of the Indian agricultural community. The time will come when the Indian agricultural community will be bound into a whole by firm and lasting agencies, but pending that time, which can only be reached by the slow process of tuition, co-operation and organisation, artificial means (European leadership and control) must be applied if greater production in agriculture is to be sought among them, more particularly among the agriculturists outside the sugar industry.

These three main points should be borne well in mind, and acted on, if the Indian agricultural community is expected to contribute in a fair measure to the agricultural production of the Colony. As colonists, and in fairness to themselves and to their adopted country, they should, and would, if the above maxims were more generally applied. When expounding these views to a European elected member lately he opposed them on the ground that it would be pampering the Indians. What fallacy! More especially when it is considered that the Indian is here for the advancement of production rather than for social reasons. Moreover, can any means wisely applied in the direction of production or greater production, be it to a human being, a horse, or a piece of machinery, be misconstrued into pamperism? For answer I direct any doubting person to the Colonial Sugar Refining Company, their treatment (pamperism?) of the Indians, and their success and profits. The necessity for the application of these main points becomes all the more evident when it is considered that due to lack of organisation and co-operation among themselves, their inborn propensity for false economy and their lack of business knowledge from a broad point of view, the Indian agriculturists and their helpers, when and wherever acting on their own initiative, that is, away from European leadership and control, find themselves at a great disadvantage in that there is no co-operative ownership of implements, live and transport stocks, nor can they perform certain essential works on co-operative lines, nor do they know what to grow, how best to grow it and how and where to dispose of it to the best advantage. This estrangement from European leadership and control leads also to a desire to live a purely village life, that is, to produce very little more of their own staple food than is needed to exist on, and, practically nothing else.

The ascertainment of the exact production by the Indian agriculturists, which includes a few indispensable Indian wage-earners, is not easily arrived at for the reason that the agricultural statistics of the Colony are unreliable, if not misleading, but a fair estimate of their production can be formed by round about means. For this purpose, I have prepared certain tables based on imports, exports and estimates which, I think, go a long way towards exhibiting the relation of the Indian agricultural community to the agricultural production of the Colony. Due allowance will have to be made for the figures based on estimates, but I venture the opinion that while the itemised figures may differ, the aggregate of the estimated production is not far out one way or the other. At any rate, it is only by large

omissions and commissions in those estimates that the *per capita* production can be materially affected. I do not, however, see where they can arise. The net result of these tables point to four important facts, viz.—

(1) that the average *per capita* production by the Indian agricultural community is not nearly as high as it should be;

(2) that the *per capita* production by the cane-growing Indian community is 157 per cent. more than the *per capita* production by the Indian agricultural community outside the cane-growing areas;

(3) that the production by the Indian agricultural community outside the cane industry, is not only very low but that it is on the decline;

(4) that the Indian agricultural community when not under the leadership and control of Europeans, ceases, practically, to be of economic importance in respect to agriculture.

Dealing with the main points of the tables, (see appendix), the following is to be gleaned:—

Imports, 1923–28.—(*a*) The average (£1,455,090) of total imports into the Colony has increased in value by 25 per cent. since 1923.

(*b*) The importation of Indian foodstuffs (rice, sharps, dhal, mustard oil, ghee, spices, potatoes and onions) has increased (in aggregate value) by about 33 per cent. since 1923.

Exports, 1923–28.—(*c*) The average value (£1,870,259) of total exports of the Colony has increased by 28 per cent. since 1923.

(*d*) The average value (£60,299) of exports of products with which Indians, as labourers only, are hardly connected, shows decrease in some products and increase in others.

(*e*) The average value (£1,148,339) of export of products (sugar, molasses and rubber) with which Indians, (as labourers and mostly as growers) are largely connected, but under leadership, control and organisation of Europeans, has increased 63 per cent and 69¾ per cent. for sugar and molasses respectively, and decreased 45·83 per cent. (£3,900) for rubber.

(*f*) The average values (£14,067) of export of products produced and controlled entirely by Indians, with slight assistance (manufacturing, shipping and sales) from Europeans, have decreased as follows:—Cotton, 50 per cent.; cotton seed, 59·44 per cent.; pineapples (fresh), 21·94 per cent.; and maize, 100 per cent.

(*g*) The average ratio (in group values) of average values of imports and exports as in (*a*), (*c*), (*d*), (*e*), and (*f*) enumerated above to the total average values of imports and exports works out as follows:—

		Per cent.	£
Imports—	(*a*)	7·24	89,896
Exports—	(*c*)	3·22	60,299
,,	(*d*)	34·81	651,090
,,	(*e*)	61·40	1,148,339
,,	(*f*)	0·75	14,067

(*h*) The total estimated average value of the locally grown and consumed products (rice, dhal, maize, pineapples, spices, tobacco, mauritius beans, milk, ghee and vegetables) over and above the values (£14,067) of such products exported, produced by Indians outside the cane-growing areas, amounts to £129,104.

(*i*) The estimated average value (£129,104) of products grown and consumed locally, treated as exports and added to the average value of total average exports (£1,870,259) increases the average value of total average

exports to £1,999,363. On this basis the percentages and values given in (*g*) now are:—

Imports—(*a*)	.. .. ..		Not affected.
Exports—(*c*)	.. ..	3·02%	60,299
,, (*d*)	.. ..	32·56%	651,090
,, (*e*)	.. ..	57·45%	1,148,339
,, (*f*)	.. ..	7·15%	143,171

(*j*) The total number of Indians estimated to be engaged in agriculture including 2,500 co-workers, is 20,750 (adult males) and their yearly *per capita* average production is £39 18s. 2d. While their distribution is:—Sugar industry, 13,750; Other industries (outside cane industry), 7,000; total, 20,750.

(*k*) The estimated *per capita* yearly production of the 13,750 Indians directly and indirectly engaged in the sugar industry is £52 11s. 0d., and that of the 7,000 Indians engaged in industries other than the sugar industry is £20 9s. 0d., leaving an increased *per capita* balance in favour of Indians under European control of 157 per cent. or £32 2s. 0d. per annum.

(*l*) The estimated Indian population at 31/12/29 is 71,000 and the occupational distribution of the population is estimated to be:—

directly and indirectly engaged in and dependent on the sugar industry, 15,000 adult males, or with women and children, 51·38 per cent. of the population;

engaged in agricultural industries, other than those of sugar, rubber, coconuts, bananas and vegetables, 7,000 adult males, or with women and children, 24·0 per cent. of the population; and

engaged in commercial, domestic, &c., enterprises and as labourers in rubber, coconut and banana industries, 7,212 adult males, or with women and children, 24·68 per cent. of the population.

Much more information could be given but I think sufficient evidence has been produced to warrant the verdict that greater production could be attained by the Indian agricultural community than has been shown, more particularly by the members of the community engaged in industries other than that of sugar. Based on the *per capita* production of those engaged in the sugar industry, the Indians outside this industry could increase their present *per capita* production by 157 per cent. that is, they could produce most of if not all the Indian foodstuff now imported (about £90,000 worth) besides providing all the rice needed for local consumption (10,000 tons) and some 500 tons more for export. Further they could produce 2,000 bales of cotton, 300 or more tons of maize, 100 tons of mauritius beans and 300 or more tons of pineapples (fresh) for export, as well as quantities of sesame, cotton seed and groundnut for the manufacture of margarine, locally, to take the place of ghee and for export, also coriander seed and linseed for export, besides many thousands of tons of pineapples for canning purposes. Regarding the Indians engaged in the sugar industry, their *per capita* production, though very fair, should be increased by the growing of rice for home consumption. For reasons to be adduced later, every man on the land, regardless of the industry he is engaged in, should be made to grow sufficient rice to provide for himself and his family.

While it is possible to increase the agricultural production of the Indian community outside the sugar industry from the present average production of £129,104 to from £300,000 to £350,000, very little improvement on the present production can be looked for unless two or more European Inspectors with an Indian staff are appointed to do all things possible to further production. The material is at hand, but needs to be moulded into shape. This

may mean much endurance and take time, but the goal is well worthy of an attempt. Chair-legislation in regard to agriculture among the Indians has ruled for many years with the poor result evidenced; let us now, I say, be up and doing for the betterment of the Indian agricultural community and for that of the Colony in the way of greater production. In the event of a desire to improve the present agricultural conditions among a certain class of the Indian agricultural community, and with the view of facilitating and expediting the carrying out of this desire, I have prepared, for Departmental use only, a set of papers giving a short local history of each product now grown by Indians, with suggestions for the growing of new ones, and making tentative recommendations for the improved and greater production of each. To assist further I would venture a general recommendation to concentrate without delay on greater production of Indian foodstuffs and on the extension of the cotton industry and the possibilities of the greater expansion of the pineapple industry to meet contingencies in the event of a set-back to the sugar industry arising from the combined effect of the total or partial removal of the preferential tariff and the low price of sugar throughout the world. Other sugar-producing countries are being sorely tried by the depressed state of the sugar market due to overproduction. Should it be found necessary to reduce the price of cane here by the removal of the bonus of three shillings per ton of cane (equal to 24 per cent or £12 on the present *per capita* production) the Indian cane-growing community would be appreciably impoverished, but should greater curtailment in the price and a reduction in the production of cane have to be made, then the large proportion of the Indian population dependent on the sugar industry would be in a very sad plight indeed unless there was sufficiency of cheap food and certain other commercial agricultural industries they could take up, to relieve the depression.

See inserted Tables.

His Excellency the Governor.—I thank Mr. Tarby for his interesting paper which indicates very careful research. The enterprise of our Indian population compares favourably with that shown in other parts of the world, but, of course, it is obvious that there is much more scope for the Indians in agriculture, and it is our object as far as we possibly can through the Agricultural Department to assist them to grow proper crops and to grow more crops. I hope the Indians present to-day will join us in the discussion and give us any information which may be of use regarding their needs.

Mr. Grant.—The trouble amongst the Indian agriculturists is finance. The Colonial Sugar Refining Company have a good system. A man might have five acres of land which he wants to plant. He works very hard and two or three acres are planted and he then finds that he cannot plant any more. I think the Government should consider the establishment of an Agricultural Bank in the same way as is done in India and if this was done it would help things along very nicely. Of course, there are money-lenders, but they want such a high rate of interest.

Mr. Turbet.—I agree with the remarks made by Mr. Grant. The Colonial Sugar Refining Company advance money to their tenants and when the crop is crushed the advances are repaid and the Indian cultivator is still left with a surplus. I think Mr. Tarby said that Indians working under that Company received £51 per annum while those working on their own only received about £20. If some means could be devised whereby

the Indians were assisted financially I think they would make a bigger return.

Mr. Grant.—With reference to the Indians working for the Colonial Sugar Refining Company they have no trouble about the cutting of their crops. They supply the labour and also pay wages. In districts like Navua for instance, all the crops are ready together and an Indian finds it difficult to get labour to help him harvest his crop.

His Excellency the Governor.—I thank you for your valuable contribution to this discussion. I am quite in agreement with your ideas. The matter is one of some difficulty and I would welcome any considered suggestions from the Indian community as to how we should go about it. I will ask Mr. Barnes whether he can devise some means which will enable the Indians to work in co-operation with the Agricultural Department.

Mr. Grant.—Some time ago six Indian lads went to India to study agriculture. They have now returned to Suva and I think it would be a good thing for Mr. Barnes to see them. I would like to see it made possible for some more Indians lads to be trained in agriculture.

Mr. Barnes.—I am very much obliged for the valuable suggestion. I shall be glad to meet those interested in agriculture. Several of your community have already visited me. I can assure you that I shall be most happy to interview any of your people at any time provided they make arrangements to see me.

Mr. Vishnu Deo.—I do not agree with Mr. Tarby's statement about Indians requiring European leadership. I think it is always better for Indian farmers to be settled on the land under nobody's control. I consider that they should be given financial assistance to enable them to get on the land. It would be better if an Agricultural Bank was established. But money is not the only trouble that Indians have to face. Sometimes they cannot get the land. They make an application and this is submitted through the usual channels and then it is turned down because the natives will not surrender the lease. Then there is the question of transport facilities which in most country districts are very poor because of the lack of roads. Produce has to be carted by bullock wagons and across rivers, and this is very expensive.

His Excellency the Governor.—This discussion is of the greatest interest to me. With regard to the leasing of land I can assure you that the question of a better system of land tenure is receiving attention and I am forwarding proposals to the Secretary of State. With regard to transport I consider that this question is entirely wrapped up in the question of the prosperity of this Colony. I hope that before long we shall have a road running direct to Sigatoka. There is also the question of subsidising small vessels to run regular trips between the various islands. I am pleased to inform you that the Secretary of State is enquiring as to the possibility of transport by seaplane between the various islands. I think this is a vital matter and I consider that an improvement in transport facilities will be of the greatest assistance to the Indian community, and indeed to the whole Colony.

Mr. Grant.—Thank you very much, Sir, for your remarks. I can assure you that we all want to co-operate with you in advancing the prosperity of the Colony.

Mr. Barnes.—I think the discussion might conveniently be closed by my summarising the important points which have been raised. The whole theme is one of organisation of Indian agriculturists. The Colonial Sugar Refining Company is, in fact, an agricultural organisation which includes provision for the points raised by Mr. Grant. Financial assistance is an

important matter in connection with their organisation. The discussion has brought out the fact that some scheme for financial and instructional assistance to Indian agriculturists is necessary and His Excellency has instructed me to prepare such a scheme for his consideration. Mr. Tarby in expressing his views has called attention to the comparatively poor returns made by Indians outside European agricultural organisations. Mr. Grant and Mr. Vishnu Deo have pointed out that the whole trouble is lack of finance—lack of capital. These difficulties have been overcome in other countries and there is no reason why they should not be overcome here. Co-operation is essential. The important points brought out in the discussion will stimulate the Agricultural Department to inquire into these vital matters.

His Excellency the Governor.—I now declare this Conference closed. I wish in the first place to congratulate Mr. Barnes on the success of this first meeting and I wish also to express my appreciation of the part taken by all members of the Department. I am always talking about education. I think education is of vital importance, but it does not merely mean the teaching of the "three R's." The first thing is to find efficient teachers, and in the staff of the Department of Agriculture I am satisfied that we have excellent men to teach the community. I might state that Mr. Barnes has suggested that future Conferences could be arranged at the time the Agricultural Show is being held, which is usually in October. I think this is an excellent idea. I hope that members of the public will contribute Papers on their own account. It would be most interesting for us to have the experience of practical men on agricultural questions.

FIJI LIVESTOCK RECORD ASSOCIATION.

MINUTES OF MEETING OF BOARD OF DIRECTORS HELD ON JANUARY 16, 1930.

THE following were present:—Superintendent of Agriculture, (Chairman), Senior Veterinary Officer, G. Kiss, Esquire, and J. Barber, Esquire.

The minutes of the last meeting of the Board were read and confirmed.

Position on Animal of Association Brand.—At a meeting of the Board held on the 24th October, 1929, the Board directed:—

"That owners of stock should be permitted to brand registered animals on such conspicuous parts of the body as they should desire."

After discussion the Board decided that, in conformity with the provisions of the Brands Ordinance, the Association's brand should be placed on the near neck or on either cheek, the earlier direction being repealed.

Annual Report.—The Board approved of the Report which has been prepared for submission to the Annual General Meeting of the Association.

Date of next Meeting.—The Board directed that the next meeting should be held on the 10th April, 1930.

MINUTES OF ANNUAL GENERAL MEETING HELD ON THE 16TH JANUARY, 1930.

The following were present:—Superintendent of Agriculture, (Chairman). Messrs C. R. Turbet, H.M. Stuchbery, J. Barber, G. Kiss, L. N. Bean, A. Barker and G. D. Hill.

The minutes of a special general meeting held on the 15th October, 1929, were read and confirmed.

Annual Report and Financial Statement.—The Honorary Secretary read the Annual Report and financial statement which were adopted on the motion of Mr. Barker, seconded by Mr. H. M. Stuchbery.

Appointment of Honorary Auditor.—On the motion of Mr. Barker, seconded by Mr. Hill, the meeting directed that Mr. P. J. A. Hamilton be requested to act as Honorary Auditor to the Association.

ANNUAL REPORT FOR THE YEAR 1929.

The Board of Directors of the Association submits the following report in respect of the year 1929.

Members will remember that the inaugural meeting of the Association was held on the 1st September, 1927, that little progress was made and that until October last the Association was, to all intents and purposes, defunct. With a view to reforming the Association the Superintendent of Agriculture, Chairman of the Board, called a meeting on the 15th October last. At that meeting, at which 12 gentlemen were present, it was decided to re-form the Association.

Election of Board of Directors.—Under the rules of the Association the Board consists of the Superintendent of Agriculture (Chairman), a Government Veterinary Officer and three elected Directors. The Directors elected at the meeting on the 15th October last were:—Mr. J. Barber, Mr. R. Craig, and Mr. G. Kiss.

The Superintendent of Agriculture appointed Mr. A. B. Ackland to be Honorary Secretary of the Association.

At the Special General Meeting members recommended to the Board of Directors that action be taken to:—

(*a*) seek approval for the use of the *Agricultural Journal* as the official organ of the Association;

(*b*) amend the Rules of the Association to provide, amongst other things, for reduced membership and registration fees.

As the Association was not re-formed until the middle of October the Board held only one meeting during the year.

The Rules of the Association have been amended on the lines proposed by members and approved by the Board and duly published in the *Royal Gazette.* They are published in the last issue of the *Agricultural Journal* and your Board now await separates for distribution to members.

His Excellency the Governor has been good enough to approve of the use of the *Agricultural Journal* as the official organ of the Association.

The Association's brand has been decided upon and application has been made for the registration thereof.

Your Secretary has addressed some 35 gentlemen in regard to becoming members of the Association. As the amendments to the Rules were not published until the 13th December it was not possible to do much towards the enrolment of members before the end of the year.

Together with the amount carried forward from 1928 the balance at the credit of the Association's Account at the 31st December, 1929 was £7. There were no items of expenditure during the year.

The financial statement placed before you at this meeting has not been audited as the appointment of an Auditor, as provided by the Rules, has not been made. Your Board of Directors recommend that the Auditor, when appointed, should examine the accounts for the year under review.

FIJI LIVESTOCK RECORD ASSOCIATION.

STATEMENT OF ACCOUNT.

Expenditure.				*Revenue.*			
To Balance carried forward to 1930	£7	0	0	By Balance brought forward	£4	0	0
				By Subscription paid 1929 .	3	0	0
	£7	0	0		£7	0	0

CONTENTS.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 3.] SECOND QUARTER, 1930. [NO. 2.

EDITORIAL.

FIJI SHOW.

Arrangements are well in hand for the Annual Fiji Show to be held in October next. This year it is hoped that the Agricultural and Horticultural Sections will be more truly representative of the Colony's primary industry. Doubtless the Show suffers from the lack of a permanent home, which necessitates a very rapid preparation of the buildings now used and hurried arrangement of many of the exhibits. Even these difficulties can be largely surmounted by closer co-operation between exhibitors and the officials of the Show. Early entries enable the available space to be planned and allocated to the best advantage.

The Department of Agriculture proposes to take a more active part in the Show this year by staging a departmental exhibit which is being prepared under the direction of a committee of senior officers. It is intended to arrange for illustrated lecturettes on important and interesting aspects of local agricultural pursuits. Members of the department will be glad to render any assistance possible to intending exhibitors.

It is felt that the objects of the Show Association are worthy of wider support by the public of Fiji. There can be no doubt that we are all primarily dependent directly or indirectly upon the success with which agricultural pursuits are carried on. The Show offers an opportunity for bringing together examples of the varied plants and crops grown in the Colony, and is important from the social aspect, offering as it does a meeting place under congenial conditions for all those people actively or passively interested in our productions and industries. The Secretary of the Fiji Show Association welcomes inquiries and will be glad to furnish information regarding both membership and participation in the Show.

AGRICULTURAL CONVENTION.

This function, foreshadowed at the Agricultural Conference held in January last under the Presidency of His Excellency the Governor, will be held during the same week as the Show, and will furnish a welcome opportunity for members of the community to discuss important questions concerning local agriculture. Details have not yet been worked out, but it is proposed to select a few of the more urgent questions of the day for consideration, among which will be the noxious weed problem, the present position and prospects of the dairying industry and copra production. The method of treatment will be by discussion, and each discussion will be opened with a short speech by some local gentleman who is intimately familiar with the subject. In order to give opportunities for speaking to as many people as possible, speakers will be asked to intimate their intention of taking part and the duration of speeches will be limited.

NOXIOUS WEEDS.

The recently issued circular and questionnaire on the subject of noxious weed control in Fiji is printed in this Journal. The response to the request for information from practical agriculturists is most gratifying and that so far collected is of great value. The data received is being abstracted and correlated with a view to publication in a later issue of the Journal. The material will be of value as a basis for extended discussion at the Agricultural Convention, and it is hoped that later it will provide a foundation for a determined campaign directed to the reduction of the serious losses to many agricultural pursuits caused by the prevalence and spread of these undesirable plants.

Information from any persons interested in the subject who have not already furnished replies or who may not have received copies of the circular will be welcomed. Additional copies of the circular and questionnaire will be supplied on application to the Superintendent of Agriculture.

GRASS LAND FARMING.

In this issue, an excerpt from an interesting and informative pamphlet, issued by Imperial Chemical Industries on the modern system of pasture control, is published. The importance to the dairying industry of proper pasture cultivation and control cannot be over-emphasised. Scientific research has clearly shown the benefits to be derived from the utilisation of grass at its period of maximum nutrient value, and has pointed the way to the increased production and profits which may be derived by dairymen who adopt this essentially sound and practicable system of pasture management. At the January Conference the limited supply of concentrates available for the stall feeding of cows in Fiji was bewailed. A method of avoiding the necessity for using any concentrates is available and can be adopted with advantage in such a country as this where growth is so luxuriant as to tempt many of our dairymen to leave their pastures until the grass is long and comparatively indigestible before grazing them. The services of officers of the department are placed at the disposal of dairy farmers who require information regarding the establishment and layout of pastures, manures and implements for grass land cultivation. Literature on the subject may be consulted in the Library at the Suva offices.

AGRICULTURAL STATISTICS.

A committee consisting of the Assistant Colonial Secretary, the Acting Secretary for Native Affairs, the Inspector-General of Constabulary and the Superintendentent of Agriculture (Chairman) was appointed to consider and report upon the method of collecting agricultural statistics. As a result of the committee's recommendations, it has been decided to alter the method of obtaining returns, to call for returns as on 1st July each year and to use a simplified schedule including only the principal crops. Returns under the new system will be called for shortly in respect of the year 1st July, 1929—30th June, 1930.

COPRA.

In his paper on the " Effect of Mould Action on Copra," Mr. Blackie has called attention to a hitherto little discussed aspect of the various factors which contribute to the deterioration and loss of copra. There is a widely held feeling that improved methods of preparing and handling copra are unlikely to be economically sound; that the small, increased return obtained by placing a better quality of product on the market will be more than

counterbalanced by the increased cost of preparation, and that the producers' interests are more likely to be best satisfied by offering for sale an article of low quality which demands a fairly ready sale rather than by attempting to improve their methods in order to secure the small advance of market price likely to accrue.

Copra preparation is an art which must call science to its aid if it is to succeed in meeting the keen competition of other vegetable oil bearing products. Arguments advanced against improved methods of preparation have in many instances been based on false premises. The few shillings extra per ton obtainable for a better quality have been allowed to obscure the possibilities of putting a greater quantity of the better quality on the market from the same amount of raw material by the adoption of improved processes of preparation.

The serious losses of produce occasioned by mould action was discussed at the recent Imperial Mycological Conference, more particularly in their relation to the cacao industry. It is evident to anyone familiar with the copra industry that similar factors exercise a grave influence on the economics of that industry, and it is clear that research is necessary to measure the losses and to evolve means of minimising them.

Mr. Blackie has discussed the problem in a deeply thoughtful manner. His paper affords a useful basis for further work and indicates a measure of the possible increased returns which may attend methods of preparation of copra directed to the reduction of losses by mould action.

MISSION TO TRINIDAD—INTRODUCTION OF LIOTHRIPS URICHI.

PREFACE.

In preparing the attached report on my mission to Trinidad to obtain the thrips *Liothrips urichi*, I have commenced with an introduction, containing first a short history of the pest *Clidemia hirta* in Fiji and the early inquiries which led up to the attempt to control it by biological methods, followed by a brief narrative of the present mission. A few details of the life history of *Liothrips urichi* have next been given and of those factors which tend to limit its numbers and efficiency, several additional enemies of this useful insect having been discovered and now recorded for the first time. Following this the natural control of *Clidemia hirta* is discussed at some length, a number of new facts being recorded which throw fresh light upon the agencies which hold this group of plants in check in their natural habitat, leading to conclusions considerably at variance with those hitherto held.

During the course of this work much assistance has been received from the various officers with whom I was brought in contact. Specimens of the various insects recorded herein have been sent to the Imperial Bureau for identification, but at the time of preparation of this report, such identification has not been received.

HISTORY OF THE PLANT CLIDEMIA HIRTA IN FIJI.

The plant *Clidemia hirta* is a member of the natural order *Melostomaceæ*, and is supposed to have been accidentally introduced into Fiji, with coffee plants from British Guiana, some time prior to 1890. It was first noticed growing along certain wire fences in the Waimanu Valley, near Suva, whence it spread into the adjoining paddocks, especially around stumps and bushes. Soon after this it began to assume the proportions of a major

weed, invading the permanent cultivations and native forests. Its spread into the pastures was particularly serious, as it soon greatly reduced their carrying capacity. There is little doubt that it was the presence of the introduced Mynah bird of India, which, feeding upon the berries and haunting cultivated lands and paddocks, led to the phenomenally rapid spread of the plant. As soon as the danger of the new introduction was realised, Knowles, then Superintendent of Agriculture, took steps to have the plant identified and to ascertain its native habitat.

About 1920 correspondence was opened with Jamaica, British Guiana and Trinidad to find out whether any agencies were known to hold the plant in check in those countries. Dry material and drawings of the flowers were also prepared by the writer and forwarded to Trinidad for comparison with the local species, recorded under the same name.

As a result of the attention thus called to it a number of plants of *Clidemia hirta* were dug up and placed in the old experimental station at St. Clair. Whilst thus under observation Mr. F. W. Urich discovered the thrips, which now bears his name, feeding upon the young foliage. He worked out its life history, recording at the same time certain natural enemies tending to hold its numbers in check. These were three in number, and will be dealt with later, together with certain additional ones discovered during the present mission. At the time that Urich made these discoveries no very great value was placed upon the controlling effect of the thrips, and no further action was taken in the matter until 1927, when Mr. T. H. C. Taylor, who was visiting Trinidad in connection with coconut work, made a "preliminary study of the plant . . . . . with a view to finding some controlling factor, which might be applied to Fiji." (Council Paper, Fiji, No. 14 of 1928.) This officer expressed a favourable opinion as to the value of the thrips and it was decided to investigate the matter further. Through the courtesy of the Principal of the Imperial College of Tropical Agriculture, Colonel Evans, a student (Mr. W. Cook) was detailed to carry out a series of feeding experiments to test whether this insect could be induced to attack any plant of economic importance, which would render it dangerous to introduce it into Fiji. This entomologist's investigations also proving favourable, it was decided to attempt the introduction of the thrips into Fiji and I was instructed to carry out the work. With this object in view I left Suva on 5th September, 1929, travelling *via* Auckland and Panama and arriving at Trinidad on 21st October.

On arrival at Port of Spain, after first calling upon His Excellency the Acting Governor and the Colonial Secretary, I went to the Experimental Station at St. Clair where I called upon the Acting Director of Agriculture, Mr. G. M. Gilbert, who introduced me to the Superintendent of the Botanical Gardens, Mr. O. H. Williams, who subsequently gave me much assistance in my work. Later in the day Mr. F. W. Urich who had made the original discoveries in connection with the thrips called and took me to a place where he was able to show the plant with the thrips at work upon it. Having finished these preliminary matters in town I proceeded to the Imperial College at St. Augustine where it was proposed that I should carry out my work. Here I was very kindly received by Mr. H. A. Ballou, who was acting during the temporary absence of the Principal, Colonel Evans, and a laboratory was placed at my disposal.

VISIT TO BRITISH GUIANA.

As soon as work was commenced it was noticed that there were certain indistinct differences between the Trinidad form of *Clidemia hirta* and that causing so much trouble in Fiji. As the Fijian species was supposed origi-

nally to have come from British Guiana, inquiries were made to see whether the plant was readily obtainable there and the reply being satisfactory a flying visit was made to Georgetown and a quantity of material obtained from that district.

A thrips similar to the Trinidad species was found to be present in small numbers, but with evidence of being more abundant in the dry season. The general appearance and growth of the plants was more like that to which we are accustomed in Fiji. This may, however, be due to the fact that the heavy wet clay is more akin to the conditions in the latter country than the rocky hills of Trinidad.

COLLECTION AND TRANSPORT OF THE MATERIAL TO FIJI.

Owing to the rocky nature of the soil in those parts of Trinidad where the plant was to be found, considerable difficulty was experienced in obtaining sufficient quantities and establishing them in the tins in reasonable time. Another difficulty was met with in the form of White Fly, which was found on most plants dug up and which in the breeding cages, increased rapidly, causing much loss. Efforts were made, by breeding from adults only, to eliminate the natural enemies of the thrips, but although their numbers were greatly reduced this was not entirely successful, and as with previous importations, careful screening was necessary on arrival.

Seventeen cages, each containing nine tins with growing plants of *Clidemia hirta* were prepared and infected. These were shipped from Trinidad on 8th February, arriving at Colon 12th February, in good condition. At Colon they were railed across to Balboa where they were held in one of the goods sheds until the departure of the "Zealandic" for Suva. This latter was delayed until 23rd February, necessitating ten full days for the plants in the darkness of the shed. This led to considerable destruction of food owing to the numbers of the thrips and the unfavourable growth conditions for the plant. Immediately the ship put to sea these were carefully gone over, cleaned up and many hundreds of thrips and pupæ renewed. The latter were placed into cool storage to check development, a method which had been tested whilst in Trinidad and which proved very successful. In addition to the insects in the breeding cages a large number of young shoots of *Clidemia* with eggs upon them had been collected just prior to sailing; these were placed in water. After much search two strong plants of what appeared to be the same species were found at Ancon. Although differing considerably in general appearance from the Trinidad or Suva form of *Clidemia hirta* it was found that the thrips took quite kindly to these also.

As a result of these combined methods an immense number eggs, nymphs, pupæ and adults of the thrips reached Fiji in good condition. To what extent this introduction will prove successful remains to be seen.

DISTRIBUTION IN FIJI.

In order to prevent the possibility of introducing any undesirable insects with the thrips, adults only were removed from the imported material, by hand, and placed upon leaves from local plants. These leaves were then laid upon growing plants, which were kept covered by a screen. In this way 2,500 adults were released by the 15th March, and a further 900 on the the 17th, when it was observed that those liberated on the 15th had commenced to oviposit upon the Fijian plants.

LIOTHRIPS URICHI, KARNY, AND ITS HOST, CLIDEMIA HIRTA.

The life history of *Liothrips urichi*, Karny, has been worked out, first by Urich and later by Taylor and Cook. The last named gave a very more-

ful description of the various stages, so that no further work on these was felt necessary, the details only being checked over. It was noticed, however, that the description of the egg, as smooth, was incorrect, it being covered with minute hexagonal pustules, which seem to have escaped observation. These pustules were absent from what is presumably the micropilar end.

The following are a few brief notes on the different stages:—

Eggs.—These are generally laid on the under surface of the terminal pair of leaves, or on the adjoining stem; occasionally, however, they were found near the base of the next older pair.

Nymphs.—These feed on the more succulent portions of the plant, either stem or leaves, and sometimes on the flower buds. In this latter case they cause the bud to drop off. They are crimson in colour with two black scutiform plates on the prothorax and two black oblong plates on the eighth segment and the tube. There are only two nymphal stages, both similarly coloured.

Prepupa —This is also crimson, but those portions which are black in the nymph, are transparent in this stage. It is easily distinguished from the pupa by the absence of wing buds and the free antennæ.

Pupa.—This is also red, but has the antennæ fixed to the sides of the head and has well developed wing buds. Both pupa and prepupa are capable of movement but take no nourishment and are placed on the undersurface of a leaf, generally congregated at the bases. These wilt, dry up and fall to the ground.

Adults.—The adults are shining black with well developed wings. They are to be found in the same situations and associating with the nymphs and pupæ.

NATURE OF DAMAGE INFLICTED UPON THE PLANT.

The insects feed, either as nymphs or adults, by sucking the juices of the plant, which develops a brown spot surrounded by a pale area at the point of attack. The adults also often attack the veins of the young leaves causing them to contract and curl over, so that the head of the attacked plant is generally distorted and has a washed-out appearance. As the terminal foliage is destroyed the nymphs move down the stems, which die back. In the case of young plants this die-back is apt to extend to the roots, which, however, are not injured and normally the plant throws up new growth unless other conditions are unfavourable. The effect of the destruction of the terminals is to give the plant a stunted appearance in those areas where the thrips is abundant, as compared to where it is absent. In the wet season, however, the attacks are less severe and the plant makes rapid growth, producing quantities of flower, and it seems probable that were it not for the destruction of these by agencies, to be mentioned further on, the effect of the thrips in preventing the spread of the plant would not be very great.

In the breeding cages it was observed that, as the terminal shoots died back, the adults did not oviposit upon older leaves, but left the plant, flying freely and crowding upon the calico sides of the cages. It was also noticed that they showed a greater tendency to oviposit in the sunshine than when the cages stood in much shade. This is also the case in the field.

NATURAL ENEMIES OF LIOTHRIPS URICHI, IN TRINIDAD.

When, in 1922, Urich discovered *Liothrips urichi*, he also found that it had several natural enemies, being attacked by a Chalcid, *Tetrastichus thriphonus* and two predators, both undetermined, one a Reduviid and the other a Cecidomyid. More recent workers do not seem to have found these checks

on the number of the thrips much in evidence. Taylor states: "Urich has bred a Chalcid parasite, *Tetrastichus thripophonus*, Wst, from the prepupæ of *Liothrips urichi*. No other natural enemies are known. We did not find this parasite, and believe it to be uncommon as a rule."

Cook states: "*Liothrips urichi* has very few natural enemies, a small hymenopterous parasite and two predators, a Cecidomyid fly larva and a small brown Reduviid bug, all discovered by Mr. Urich, are the only ones known." He goes on to say that he only found one of these, the Cecidomyid, and that this: "was only observed on comparatively few occasions."

In the course of the very large amount of material examined on this Mission it was found that natural enemies were more in evidence than earlier workers had believed, several additional species being met with. The most important was undoubtedly the Cecidomyid, which was often very abundant, there being sometimes as many as three larvæ on one leaf. In these cases they quickly destroyed all the thrips present, attacking these in the nymphal stage and it was concluded that, whilst perhaps not actually specific, this insect was a special enemy of the thrips and that it probably destroyed 30 per cent. to 40 per cent.

The Reduviid was found as a somewhat scarce predator and may be a general feeder. It was present in the breeding cages, where the eggs were discovered. These are a pinkish-yellow, shaped like a soda water bottle, with a white fringe around the operculum and were found two side by side on the surface of the main terminal of the plant.

The Chalcid was met with only on one occasion and is evidently not abundant upon this insect, but there is reason to suppose that it may have other hosts.

In addition to these already known enemies of the thrips several new ones were met with. The most important of these was a predatory mite, shown in Fig. 9.* It is crimson in colour and hard to find as an adult as it had a habit of jumping from a leaf when this was touched. It was observed to attack both nymphs and adults. Being exceedingly small it easily escapes observation and this makes it difficult to estimate the extent of its attack.

A small black bug, rather larger than an adult thrips, which it decidedly resembles, was observed to suck the eggs of the thrips and occasionally destroy the pupæ. This species was only discovered towards the end of the investigation and the extent of its influence is unknown, but one bug is capable of destroying a very large number of the thrips.

In addition to the above which may be special enemies of the thrips, several general predators were observed feeding upon this insect. One of these, a small jumping spider, was not uncommon, but its effect would be hard to estimate. Another was the green larva of a Syrphis fly, which could destroy as many as seven nymphs in a night. This fly was not reared to maturity and was only met with on about three occasions. Ladybirds were also bred out of infected material and may destroy a certain number, but were more likely predatory upon scale insects.

From the above it will be seen that *Liothrips* has in Trinidad a considerable number of natural enemies, the elimination of which should greatly increase its efficiency in Fiji. There are, however, in the latter country several species of thrips, which are all rare insects, and may have special enemies holding them in check. In this case it is possible that some of these may turn their attention to the new introduction and thus offset the effect of such screening out. This, however, can be tested only by time.

* Figures not reproduced.

Fungus destroys a certain number of both nymphs and adults and on one stem of *Clidemia* gathered in the wet Aripo Valley five out of nine had been destroyed by this agency. This fungus caused considerable losses in my breeding cages and is probably allied to *Sporotrichum globuliferum* which which often proves very fatal to the cacao thrips.

CLIMATIC CONDITIONS DETRIMENTAL TO THE THRIPS.

Liothrips urichi is reported as being more abundant in the dry season than in the wet. The writer was in Trinidad mostly in the wet season and his experience tends to bear this out. It was observed that whilst the thrips was to be found all over the island it was very scarce at this season of the year in the wet Mora Forest and along the Cumuto Road, in the Central Ranges whilst it was far less common in the wet Arima Forest than in some other parts, considerable clumps of the plant being free. In such localities the plant grew into tall bushes 6 or 8 feet high, but was no more abundant than in other places where the thrips led to a stunted growth. It was also observed, both in the laboratory and in the field that the insect did not like dense shade, and did not oviposit freely in such situations.

Those districts in Fiji in which *Clidemia* hirta has become such a pest are considerably wetter even than the Mora Forest, and it remains to be seen whether there are favourable factors which will compensate for this somewhat unsuitable climatic environment.

THE NATURAL CONTROL OF CLIDEMIA HIRTA AND ITS ALLIES IN TRINIDAD AND FIJI.

Three and a half months were spent in collecting and preparing the material which was to be sent to Fiji and, whilst carrying out this work, it was decided to investigate further the causes which inhibited the spread of *Clidemia hirta* in Trinidad, as it was felt that there were other and more powerful agencies present than the thrips. Further it was observed that the thrips did not thrive in certain wet districts and this intolerance of wet conditions suggested a possibility that the insect might not thrive in the far wetter climate of Fiji. In view of the seriousness of the weed in Fiji it was felt that every effort should be made to ascertain whether any other agencies were present, checking the spread of the plant in Trinidad. The resulting investigations were attended with a considerable measure of success and a number of discoveries made regarding the biological control, not only of *hirta*, but of all the members of the genus, and resulted in conclusions greatly at variance with those previously held.

Habitat.—The *Melostomaceæ*, to which order the genus *Clidemia* belongs, are a dominant group in the West Indies, being rich in both numbers and species. They occur as small shrubs, similar to *Clidemia hirta*, up to bushy trees 12 or 15 feet in height. They require a good deal of moisture and in Trinidad form a considerable portion of the secondary growth about the foothills.

Clidemia is represented by a number of species, the commonest being, *pustulata, hirta, dentata, rubra* and *neglecta*. All these have similar habits, being found along the forest traces and in the partial shade of secondary growth and in clearing in the jungles. None of the genus was ever seen in the dense masses characteristic of *C. hirta* in Fiji, but both *pustulata* and *hirta* were abundant in places, the former being the only member of the group to occur anywhere in such numbers as to constitute a weed. This it did in two or three places, notably in a clearing in the poor land near the railway at Arima and again near Sangre Grande, in what is known as the Long Stretch, where it formed a considerable portion of the growth along the edge of the road.

Competition.—It has been suggested that competition of other plants is an important check upon the spread of this other and weeds and Cook gave a list of the plant association in which *hirta* was found. There is no doubt that competition is a factor, but the present investigations indicate that this competition takes its most intensive form in the effort of the plants to produce sufficient seeds to overcome the losses, which will be indicated later, and thus to reach suitable habitats as they become exposed. Once the seedling is established in its new haunt it seems capable of competing with the secondary growth, and produces seeds until such time as a new competition arises, caused by the growth of taller vegetation, which nursed under the shelter of the secondary, sun loving plants, eventually shades them out.

Ecology.—It has also been suggested that ecological factors were the paramount ones in deciding the relative abundance of the various species in any plant association. The present investigations, however, indicate that it is the biological factors which control the numbers, although of course the ecological factors will decide whether a plant shall be actually present in, or totally absent from any locality to which its seeds have access. It seems also probable that where the ecological conditions are only partially favourable that the plant will be replaced by other more suited species, rather than that it will continue to exist in small numbers only.

In any case, when a plant has invaded a new country to the extent to become a major noxious weed, it shows that the ecological conditions are favourable and, as in most cases, it would be impossible to change these permanently over any considerable area, it is only from biological methods that relief can be hoped.

BIOLOGICAL AGENCIES.

In approaching the matter from a biological standpoint three main lines of study suggest themselves:—

1. Those factors which assist the seeds to occupy quickly any suitable positions that become vacant.
2. Those factors which lead to the destruction of the seeds either before or after production.
3. Those factors which weaken the plant sufficiently to reduce seed production.

To deal first with those agencies which assist the spread of the plant in Fiji. The fruits of the various species of *Clidemia* are small purple berries, much relished by certain birds. Jepson has shown that the small seeds pass through the alimentary canal undigested and are thus distributed. There is little doubt that it was the presence of the Indian Mynah bird which, haunting cultivated lands and pastures, led to the very rapid spread of the weed in Fiji. It is of interest that the same bird is also considered the main agency in the spread of another weed, *Lantana* in that country. Other birds also assisted in distributing the new plant, particularly doves and pigeons and these are probably the chief agencies in the bush and forest country.

AGENCIES WHICH CHECK THE SPREAD OF THE PLANT IN FIJI.

Ecologically Fiji proved highly favourable to the plant, which rapidly occupied large areas in the wetter portions of the group. There have, however, been a few reports of the plant dying out from areas where it formerly flourished. The first of these was in 1919 and was investigated by the writer. The cause of the death of the weed proved to be connected with the attacks on the roots by a nematode of the *Heterodera* group. either

directly or indirectly by allowing the entrance of parasitic fungi. The disease was found to be confined to certain of the poorest classes of land, and whilst one or two other reports of a similar nature and due to the same agencies have come in, it has always been on the same poor type of soil and of little economic value in the control of the plant.

AGENCIES WHICH ASSIST IN SPREADING THE PLANT IN TRINIDAD.

In Trinidad doves are numerous and I am informed that the berries of these plants are often to be found amongst their stomach contents. These are forest and tree loving birds and whilst there are doubtless other species which feed upon this class of berry, there does not seem to be any with quite the same habits as the Indian Mynah to spread the plant over pastures and cultivated lands.

AGENCIES WHICH ASSIST IN PREVENTING THE SPREAD OF THE PLANT IN TRINIDAD.

In studying those causes which prevented this plant spreading unduly, it was frequently noticed towards the end of the wet season that there were numerous patches of bare soil along the forest traces, frequently damp and moss clad, ideal as seed beds for *Clidemia hirta* and its allies, which were unoccupied, and which would, in Fiji, produce quantities of young seedlings of the plant. Their absence in Trinidad did not suggest that the position was unsuitable, but rather that the seeds were not there to occupy the favourable situation thus exposed. In support of this conclusion Taylor states in his report on his investigations into the natural control of the plant in Trinidad: "We were impressed with the scarcity of fruit on *Clidemia* all over Trinidad," suggesting as a reason that "the thrips certainly plays an appreciable part in producing this state of things." Whilst agreeing as to this scarcity of fruit I was not satisfied that the thrips was the principal factor in bringing it about for the following reasons:—

1. The thrips was absent from all other species of *Clidemia*, yet the same failure to produce seeds was equally noticeable in these.
2. The thrips was absent or almost absent in certain wet districts and under the shade of cacao at places, yet although the plant grew luxuriantly it showed no signs of spreading unduly and there was still the same paucity of berries.

It was felt that the key to the position lay in the absence of seeds and investigation of the causes showed, that from the moment that the buds are formed until they reach maturity they are subject to the attacks of a series of insect enemies, which exert a pressure so severe as to result in the destruction of probably over 95 per cent. The conclusion was arrived at that it was seed destruction that was preventing the undue spread, not only of this plant, but also of all other species of the genus.

These controlling agencies were found to belong to a number of different species and even to different orders; some general, some specific and other apparently generic in their feeding habits.

INSECTS WHICH DESTROY THE SEEDS OF CLIDEMIA HIRTA, IN TRINIDAD.

Of those insects which destroy the seeds of *Clidemia hirta* the most abundant is probably a small Chalcid, which forms hard galls within the berries. At the time of my arrival it was present in probably 95 per cent. of all berries which reached full growth, but as the dry season advanced it grew scarcer, possibly due to an increasing wave of parasitic pressure and several localities were found from which it seemed to be absent. The effects

of its attacks varied with the size of the berry and the number of the insects present. If the attack did not take place until the berry was nearly full grown, and only one Chalcid was present, this gall was generally in the central pith and little damage seemed to result. If, however, the attack took place earlier it generally resulted in the premature fall of the berry, whilst if, as was usually the case, a number of galls were present in the same capsule, there took place a hardening of the tissues together with premature ripening, and loss of healthy seeds. Such berries were generally enlarged and very distorted. This Chalcid (Fig. 11) was subject to the attacks of a second Chalcid (Fig. 10) which was very abundant whilst a Braconid also occurred. This valuable species seems to be absolutely confined to *C. hirta*.

Lepidoptera.—Next to the Chalcid the most numerous of the seed destroying insects was a very small pink caterpillar. As a destroyer of seeds this was possibly the most important single agency. It was found commonly in the seed capsules of both *hirta* and *pustulata*, probably also attacking the other species of the genus. It showed a preference for the younger berries, but also attacked older and even ripe ones, causing them to fall prematurely, with total destruction of their contents. When fully fed the larva leaves the berry and spins a tough silken cocoon at the junction of two veins of a leaf or in a shallow in the stem, weaving a few hairs from the plant into its shelter.

The most remarkable thing about this insect is, however, that there is on *C. pustulata* a moth which forms galls in the stem, but which is never found in *C. hirta*. This moth is morphologically indistinguishable from this insect, but does not leave the shelter of the gall to pupate, whilst the caterpillar seems to be more variable. It seems probable that it is biologically distinct as its incidence did not always correspond with that of the seed-eating form. (See Figs. 17 and 23, resting position, also Fig. 22 larva.) Almost as abundant was a small greenish white caterpillar, resulting in the grey moth shown in Fig. 16. It attacked the berries at stages, causing them to fall off prematurely resulting in their total loss. This or a closely allied species was found to be the most abundant of the seed destroying agencies in the patch of *Clidemia* examined in British Guiana. Whilst what may be the same species was observed, but not bred out, feeding beneath the flower buds of *C. pustulata*, causing them to fall without opening.

In Fig. 15 is shown a pretty pinkish moth which was bred from an external feeding green larva and also from internal white ones. Time did not permit of checking this over and it seems probable that a mistake has occurred. The larva in the laboratory spun its cocoon as a rule between two berries. It was found (unless some confusion of the species has occurred) to be parasitised by a brown Braconid, shown in Fig. 12, which pupated within the berry. It is not always easy to be certain to which larva these internal species belong, as if removed from their surroundings they will seldom return and the breeding of the moth from the green external feeder suggests that an error has been made, although is it possible that the species is occasionally external in its habits, and the effect of the light is to bring out the green colour.

External Feeding Lepidoptera.—Siderus leucophagus.—Fig. 19 top and underside; Fig. 18 larva. The larva of this beautiful butterfly was found feeding upon the flowers and berries of *C. hirta*. The butterfly was never seen, but the larvæ were found from time to time. They match their surroundings most perfectly and were very difficult to discover. Like all the group it suffers much from the attacks of enemies and in the laboratory a nematode (Mermis sp.) was bred out. Its attacks on the berries resulted

in their total destruction, as they hollowed the interior completely out. Although rare in Trinidad, in another country, relieved of its natural enemies it might become of considerable value and it has the advantage of belonging to a group usually highly specialised in regard to feeding habits.

Fig. 13 is another external feeder. The larva is generally pink speckled with black, but is somewhat variable. As a rule it spins the flowers together and feeds upon the buds and young berries. One specimen was met with right inside a berry. The moth was first bred out by Urich. It is a most remarkable insect, with immensely long labial palpi, which are banded black and white, and are curved back over its head. The legs are also decorated in the same striking contrasts.

Another external feeder is shown in Fig. 21 (adult) whilst the larva is shown in Fig. 20. It was found in wet Arima reserve. The larva possesses very attenuated thoracic segments, and feeds by making a small hole in the side of a berry and completely clearing out the contents. It also constructs a funnel of silk, within which it lives and pupates. The adult moth is very beautifully coloured in brown and a metallic shade of silvery white.

Leaf Feeding Insects.—A number of insects were found to feed upon the foliage of the plant, but none would be safe to introduce into another country. In the field the most frequently seen of these leaf insects was the Pyralid moth shown in Fig. 14. The larva of this species is a leaf roller and was found to be not uncommon.

A second species made a hard case out of silk, recalling the cocoon of the European Puss Moths. This larva was brown with a yellow stripe on each segment and lived within the case, leaving an opening at each end to allow it to come out to feed. When full fed it closed the two ends forming a barrel shaped cocoon and pupated within.

Another lepidopterous insect was a leaf miner. This was not bred out and was, in Trinidad, of no importance.

A few specimens of a curious phytophagus beetle were bred in the cages and subsequently met with in the field.

Three homoptera proved troublesome in the cages. The worst of these was a species of Aleyrodes (white fly) which not only destroyed the foliage, but attracted ants. Next, in point of numbers, was a mealy bug, which became very bad in one or two of the cages, whilst the last of this group, also in the cages, was a yellow scale, of the Lecanium type.

Fungus Diseases.—In one or two of the wetter valley a fungus was observed on the foliage. This was identified as an Irenia sp., a group described as mildly parasitic.

INCIDENCE OF THE VARIOUS CONTROLLING FACTORS.

It was observed that the incidence of the various controlling factors varied greatly. Thus, in several of the wetter districts, such as the Mora Forest, the Arima Reserve and some portions of the Central Ranges, the thrips was practically absent. In these localities the weed grew into fine bushes six and even eight feet high. In the Central Range locality the gall Chalcid was also missing and control was almost entirely by the internal and external seed caterpillars, principally by the pink one. In a batch of berries collected in the Maracas Valley the white larva producing the moth shown in Fig. 16 was the most abundant species. It was also observed that as the dry season advanced there was a considerable change in the insects attacking the plant.

EFFECT OF INSECT ATTACKS UPON SEED PRODUCTION IN CLIDEMIA HIRTA.

A large number of berries of *Clidemia hirta* collected in different localities were opened and an examination of the contents made. A typical specimen will be detailed here, and it is proposed to tabulate a few others as an appendix.

The branch in question was taken from a fine plant, some six feet high, growing in the wet Arima Forest. It was one of a group that were free from attack by thrips, but although evidently long established there were no young plants found and the group was not apparently spreading with any rapidity. On this branch there were three fruiting bunches, the oldest consisting of only two berries, about half grown and both completely eaten out by lepidopterous larvæ. There was no doubt that the others on this bunch had all fallen prematurely from insect agency.

The next younger bunch consisted of eleven berries, six being green and five brown. Of the green ones four contained caterpillars and two were still sound, whilst all the brown ones had been eaten out by caterpillars. In the youngest bunch there was an unopened bud and one flower, both normal. There was one sound berry, six brown buds, five having been hollowed out by caterpillars and five green berries also containing caterpillars.

It will thus be seen that exclusive of the buds and flower, there were twenty berries, of which only three were still sound and these would still have to run the gauntlet of further caterpillar attacks and as they reached half size, become liable to the attacks of Chalcids. It will thus be realised how heavy is the pressure exercised by these seed-destroying agencies and the conclusion was forced upon me that it was considerably over 95 per cent. of the possible production that was thus destroyed perhaps over 99 per cent. In British Guiana it was noticed that the bud and flower destroyers were not so much in evidence and that the plants set far more berries. The pink caterpillars was not found, but is doubtless present in places. As a consequence there were far more berries, but these were nearly all attacked by the greenish-white larva, with what ultimate effect I was, however, unable to ascertain. The destruction must, however, be very severe.

CONCLUSION.

In Trinidad the plant *Clidemia hirta* is subject to a considerable number of insect enemies, which prevent its undue spread. The most important of these seem to be those species which destroy the flowers and seeds. These collectively seem to destroy over 95 per cent. of the possible seed production. This destruction is common to all the members of the genus, but the casual agencies are not always the same. *C. hirta* alone seems to be attacked by the gall seed Chalcid and, with the single exception of the *C. dentata* record, is the only host of the thrips. Whether this is offset by an ability to produce a greater quantity of seed than other species of the genus I would not like to say, but it did seem that *hirta* and *pustulata* were more continuously in flower than the others.

It was found that the value of the thrips as a control was much reduced by its own natural enemies and every effort was made to reduce as far as possible the numbers of such gaining access to the cages. If success is attained in screening these out the efficiency of the insect should be greatly increased; but, in Trinidad, *Liothrips* was particularly susceptible to wet conditions and as the areas of Fiji in which *Clidemia hirta* is found are, as a rule, very much wetter than Trinidad, it remains to be seen whether any success that has been met with in screening out natural enemies will be

sufficient to offset this probable unfavourable environmental condition. Should, however, it be found that the effect of the thrips in Fiji is not so great as could be desired the insects discovered in the present Mission and discussed in this report offer encouraging prospects of eventually being able to bring this troublesome weed under close biological control.

In the Appendix will be found details of-

(1) Seed Examination.

(2) Temperature Experiments.

(3) Technique.

THANKS.

In conclusion I would like to express my sincere thanks to Col. G. Evans, Director of the Imperial College, who placed a laboratory at my disposal and extended much hospitality; to Professor H. A. Ballou, for kind assistance and advice; to Mr. S. M. Gilbert, Acting Director of Agriculture, who also rendered every assistance in his power.

I am particularly indebted to Messrs. F. W. Urich and R. O. William, who placed their great knowledge of the local entomology and botany at my disposal, besides assisting in many other ways. I have also to thank Mr. R. Dick for naming specimens.

My sincere thanks are due to Mr. B. Martyn, Mycologist, British Guiana, who assisted in the very wet and dirty task of obtaining the plants from that country, and to the Government Entomologist, Mr. L. D. Cleare, for kind hospitality.

I am also greatly indebted to His Excellency Col. Burgess, Governor of the Canal Zone, who instructed that my cages should be railed from Colon to Balboa free of cost to this country.

Finally to Dr. J. Zetek of the Department of Agriculture, stationed at Panama Canal Zone for kind hospitality and assistance, as also to Captain Jones of Andrews & Co., and Mr. W. Smith of Elders & Fyffe, for assistance in shipping my cages.

H. W. SIMMONDS,
Government Entomologist.

APPENDIX A.

TECHNIQUE FOR HANDLING LIOTHRIPS URICHI.

Previous workers have removed adult thrips by means of a blunt pointed needle, a tedious and slow method, resulting in the injury of a number of the insects. Effort was therefore made to evolve a more satisfactory system and the following was found to work well:-

Infected material was collected in the field and carefully gone over with the lens, any adults present being removed by means of the needle. The leaves were then roughly sorted into two lots; one, in which pupæ predominated, and the other consisting of nymphs. The former was then allowed to dry off for about 36 hours, when it was placed into a closed tin, interlaid with portion of fresh leaves and left for a night. The nymphs soon left the dry material for the fresh, whilst the pupæ remained behind, so that a pure culture was obtained of pupæ on the one hand, on the dry leaves and of nymphs on the fresh. The pupæ were then placed into a box until the commenced to emerge, when a few fragments of leaves that had been carefully examined with the lens for undesirables were introduced and kept closed until next day. It was then found that the newly hatched adults would have collected on the fresh leaves, and in this way could be handled in large numbers without loss.

When a fair number of pupæ had collected amongst the nymphs these were again dried off and the pupæ separated from the remaining nymphs.

By using mason jars or tins food could be kept sufficiently fresh for a number of days. It was, however, found necessary to open up the jars each day, otherwise sufficient carbon-di-oxide was given off to kill all life present.

TEMPERATURE EXPERIMENTS.

In order to test the value of cooling to assist in the transport of any material that may subsequently be required, one or two temperature experiments were carried out:—

1. A set of berries, numbering 96, were placed in a cool chamber at a temperature of 55° Fahr., remaining there ten days. When removed Chalcids commenced to emerge at once and continued to do so for 18 days. From this it seems that the effect of this temperature is only slightly to delay development, regardless of the stage in which the insect is at the time placed in the cooler. In addition, four moths emerged on the 18th and 20th days. It seemed to show that these insects could only stand chilling when in one stage, possibly egg or possibly pupal, followed by delayed development.

2. A second box containing fully developed nymphs and pupæ of *Liothrips urichi*, was subjected to similar treatment for twenty-one days, all surviving.

APPENDIX C.

RECORDS OF SEED EXAMINATIONS IN CLIDEMIA HIRTA.

In addition to the records of seed destruction given in the text a large number of berries were cut open and a record was kept of a few of the more interesting of these, some of which are detailed below:—

1. A set of twelve berries, almost ripe, were collected from the plant and opened up, when it was found that all had been attacked by insects, six being caterpillars, five Chalcids and one by both.
2. Four berries from under the plant in the Mora Forest were found to contain caterpillars in three and the fourth had one of the only two thrips met in that wet area.
3. Twenty ripe berries collected under bushes in the Northern Ranges consisted of five sound ones, seven containing Chalcids, five of which were quite destroyed and seven totally destroyed by caterpillars, whilst two had dropped from some unknown agency.
4. Twelve seeds picked up under bushes in the Northern Ranges had all been destroyed by caterpillars and Chalcids in equal porportions.
5. Six buds found under the same bushes had all been attacked by insects.
6. Thirteen buds and young berries found under bushes at Arima had, in eleven cases, been eaten out by caterpillars and one had an external wound.
7. A large batch of full grown berries gathered at Maracas were about 95 per cent. attacked by Chalcids, with caterpillars also present.
8. Forty-three berries from under plants at St. Johns consisted of 23 destroyed as recently set buds, probably all the work of caterpillars, eleven eaten out by the same agencies, three contained both caterpillars and Chalcids and five contained Chalcids only. Of the balance four were big berries totally destroyed by external feeders and five contained Chalcids or caterpillars, but had not been so severely damaged and might mature a few less seeds. There was not a sound berry in the whole lot.

MARKETING OF FIJI FRUIT IN NEW ZEALAND.

By JAMES KERMACK, Assistant Superintendent of Agriculture and Inspector of Produce.

As directed by His Excellency the Governor, I proceeded to Auckland, New Zealand, by the s.s. "Tofua," on 13th February, for the purpose of observing conditions under which Fijian fruit is carried, discharged, and marketed in New Zealand, and of investigating market conditions in regard to bananas and other produce. After careful observations, which were continued over a period of approximately three weeks, of the various operations relative to

the transport and ultimate distribution to retail merchants of banana consignments, which was the primary object of my mission, and from investigations I made regarding possibilities of markets in New Zealand for a much larger export of produce from the Colony I submit the following information:—

TRANSPORT OF BANANAS TO AUCKLAND.

2. The steamer on which I travelled carried 6,160 cases of bananas put on board in four holds at Suva on the 16th and 17th February, and consigned to the undermentioned Agents and fruit buyers in Auckland:

A. B. Donald, Ltd.,
Turners and Growers, Ltd.,
Radleys, Ltd.

The fruit, the greater part of which had been harvested at least four days prior to shipment, was on arrival at the wharf at Suva found to be in an unsatisfactory condition. A considerable percentage was overfull and commencing to ripen, whilst a proportion was immature and diseased and although several shippers endeavoured to improve matters by repacking, the danger of the cargo reaching New Zealand in a poor marketable condition was only too obvious. Loading operations left a great deal to be desired in respect of proper handling and I am of opinion that a discontinuance by the Steamship Company of the present "rope sling" system and by substituting "trays," the risk of cases being damaged and consequently fruit bruised by crushing, would be considerably lessened. Every care was, however, taken by the ship's officials in the stowing and dunnaging of the cases and as there was ample room in the holds for a very much larger shipment, ventilation was good and gas from ripening fruit was readily expelled by a fan system which operated from the time loading operations commenced and throughout the voyage to Auckland. I visited the holds of the vessel each day during the period of transport and found that whilst for the first two days there was little or no appreciable change in the appearance of the fruit, a general ripening in many lines commenced on the third day. I attribute the early general ripening solely to the unsatisfactory condition of the fruit at the time it was put on board. Ideal weather conditions for transport did not necessitate the steamer holds being closed during any stage of the voyage and temperatures were even and comparatively cool from the time the vessel left Suva until Auckland was reached.

DISCHARGE OF CARGO AT AUCKLAND.

3. I observed very closely unloading operations which commenced soon after the vessel was tied up alongside the wharf at Auckland. A considerable amount of care was exercised in discharging the cargo on to the wharf on "trays" bu I was by no means favourably impressed with the manner in which it was handled by wharf labourers from the ship's side to Customs sheds, cases being frequently lifted from hand trolleys by which means they are transported and literally thrown one on top of another in different piles. I complained on several occasions to the Fruit Inspector who was on duty about the rough treatment the fruit was subjected to and was informed by that official that any interference on his or the Shipping Company's part would probably result in a general strike of wharf labourers, all of whom are associated with strong Unions.

INSPECTION OF FRUIT IN CUSTOMS SHEDS.

4. As I had anticipated, a large proportion of the shipment was found to be in bad condition and shipper's agents, who I learned make as a rule a cursory examination only of the fruit in Customs sheds, experienced on

this occasion great difficulty in selecting from the different lines the quantity of cases of what they considered to be sound fruit ordered by clients for immediate delivery. No systematic inspection was made by the Government Fruit Inspector and approximately 50 per cent. of the cargo was distributed from Customs sheds immediately after shippers' agents had made their Survey. I inquired of the Fruit Inspector the source of information he supplied periodically to the Department of Agriculture, Suva, in regard to the condition of shipments arriving in Auckland from Fiji throughout the year, and he reluctantly had to admit that it was supplied to him by an official of one of the shippers' agents. This admission did not come altogether as a surprise to me after I had been in the Customs sheds but a short time. I do not suggest that the information submitted by the Fruit Inspector is unreliable but his method of procuring it is, in my opinion, irregular and may lead, if it is continued, to the Government of Fiji on occasions taking undue drastic action against shippers whose fruit may possibly have been adversely reported on by an agent's employee in error during the hurried period of distribution in the Customs sheds. The position, however, in regard to fruit inspection in Auckland at present would appear to me to be a difficult one as the Inspector is expected by Government to do the work without any assistance whatsoever. To make a thorough inspection of each line of fruit in the short space of time available prior to distribution, a fairly large staff of competent inspectors would, in my opinion, be necessary.

REPACKING OF FRUIT IN AGENTS' SHEDS.

5. I have already stated that approximately 50 per cent. of the cargo was distributed without proper examination. The remaining 50 per cent. was trucked to the sheds of the different agents where cases were emptied, fruit graded, repacked and sold either by auction or by private sale. I followed closely each operation and was favourably impressed with the careful and expeditious manner in which the fruit was handled. Considering the speed and accuracy with which the culling and grading was carried on it was perfectly obvious to me that a number of specially trained employees are on hand at all times to do this class of work. This would mean that repacking of indifferent fruit has frequently to be resorted to. Here I had also an opportunity of arriving at an estimate of the condition of the shipment. On the assumption that a high proportion of the 50 per cent. distributed without inspection was in a similar condition to the proportion repacked and from my observations in the Customs sheds it may reasonably be inferred that the shipment was the worst since th new Banana Regulations came into force in Fiji in September, 1928. The following statement compiled from notes I made in course of my observations in repacking sheds compares favourably with information I was able to procure from shippers' agents and therefore may be accepted as being correct:—

Total shipment		6,160 cases
Sold without examination	3,023 cases	
Examined and found to be in the following condition—		
Green	1,558 ,,	
Ripe and soft	747 ,,	
Over-ripe, immature and diseased .	832 ,,	
		6,160 ,,

MARKETING IN CUSTOMS SHEDS AND IN AGENTS' PREMISES.

6. The maximum price governed more or less by supply and demand is arranged by mutual agreement between shippers' agents when they have

ascertained the extent of the shipment and after they have roughly estimated the condition of the fruit. I was not able to find out for what price unexamined fruit sold, but I had some evidence that about 27/6, which I was informed was the maximum on this occasion, was obtained. In the agents' auction rooms prices for repacked fruit ranged from 12/6 to 27/6 according to condition and averaged, as near as I could estimate at times when I attended auctions, 20/- per case. I was satisfied that sales of repacked fruit in agent's premises by auction were conducted in a perfectly straightforward manner and I have no reason to doubt that other sales made by private bargain in Customs sheds and elsewhere were similarly conducted.

VISITS TO RETAIL STORES.

7. Periodically during the first week of my stay in Auckland I visited the principal retail stores in and around the city and from observations I made merchants appeared to have little or no difficulty in disposing of bananas at prices ranging from 4d. to 6d. per lb. It would be difficult to estimate the return to the retailer as occasionally the smaller and poorer fruit I observed was offered for sale by quantity at so much per dozen but I was satisfied that sales by weight of repacked fruit from agents' sheds must have been profitable. The net weight of a case of sound bananas is approximately 80 lb and as the estimated cost to the retailers on this occasion was 20/- per case, a gross profit from sales at an average price to the consumer of 5d. per lb would be 13/4 per case. In considering this apparent high return it must, however, be borne in mind that the retail merchants run considerable risk in stocking ripe bananas during the warm season and are liable to lose through the fruit going bad if there is not an immediate demand. I questioned several of the leading storekeepers regarding banana sales, and all were of opinion that if the fruit were available and could be imported and sold to retail merchants at a reasonable price a very large business would result. In this I quite agree as frequently I overheard remarks of intending purchasers who hesitated to buy on account of high prices asked.

VISIT TO WELLINGTON.

8. After I had studied, for over a week, the situation in Auckland I proceeded to Wellington where I spent four days. Market conditions there, in respect of prices, I found on inquiry to be very similar to those which obtained in Auckland. Unfortunately I had no opportunity of seeing any bananas landed or auctioned in Wellington, but I was informed that only small consignments reach that port principally from Rarotonga and Samoa. When available a quantity of Fiji bananas is despatched by rail each month from Auckland, and I gathered from retail merchants that no difficulty whatsoever is experienced in disposing of such even at high prices. With letters of introduction from the Hon. the Colonial Secretary, I called on the Director of Agriculture and the Comptroller of Customs. The latter official was not on duty when I called and I had not an opportunity of seeing him before I left the city. I met his deputy, however, and whilst both he and the Director of Agriculture showed me every courtesy neither official could assist me very much in my investigations of local marketing conditions. I had a long and interesting conversation with the Director of Agriculture, Dr. Reakes, who was very sympathetic in his attitude towards importations into New Zealand of Fiji produce.

RETURN TO AUCKLAND FROM WELLINGTON.

9. I returned to Auckland on 28th February and had an opportunity the following day of seeing a shipment of approximately 6,000 cases of

Samoan bananas landed from the New Zealand Government boat "Maui Pomare" an insulated vessel specially constructed for the carriage of fruit. It was interesting to compare the shipment with Fijian consignments of the previous fortnight to Auckland and I regret to record that the condition of the Samoan fruit was by far superior. As near as I could estimate 15 per cent. only was yellow but not over-ripe whilst the remainder appeared to be green and firm.

INVESTIGATIONS REGARDING POSSIBILITIES OF LARGER MARKETS IN NEW ZEALAND FOR FIJI PRODUCE.

10. I employed the remaining few days of my visit to New Zealand investigating possibilities of increased markets for Fiji bananas and other produce and discussed the question with several of the leading fruit agents and merchants in Auckland. Without exception all were most enthusiastic over an extensive development of the banana trade. The public, they contended, are clamouring for bananas and insist on having the Fiji product but at a cheaper price. At present the fruit is an expensive luxury almost outside the reach of the ordinary individual and if conditions remain as they are for much longer merchants claim that the working man, recognised to be the largest consumer will, of necessity, cease to be a purchaser. One of the leading Auckland fruit agents informed me he was satisfied that from 60,000 to 70,000 cases if not more of Fiji bananas placed on the market at a reasonable price would readily be absorbed in New Zealand each month if properly distributed among the larger cities. I do not for a moment doubt this assertion but whilst the public are demanding more fruit they also expect to get it of the best quality. Recent shipments to Auckland have not, I should say, been a good advertisement for Fiji bananas and in my opinion it has been due only to a shortage in the market that little difficulty has been experienced by merchants in making sales. Shippers have, I am afraid, in view of this shortage been too prone to fill cases with indifferent fruit which in normal times would be rejected by them as unsuitable for export and have not considered the necessity of maintaining the highest possible standard in order to foster what should be a much more important industry in the Colony. There would appear to be a very limited demand in New Zealand for tropical fresh fruits other than bananas and whilst I suggested to merchants different varieties which in time could be supplied by Fiji in large quantities if required, they were perfectly candid in stating that the public would not be interested. For citrus there is a good market, oranges, mandarins, Lisbon lemons and grape-fruit being imported in fairly large quantities from Australia and the United States of America. No attempt has been made by Fiji to cater for the citrus trade in New Zealand and I am of opinion that there is an excellent opportunity awaiting growers who would produce the best varieties and grade and pack the fruit in accordance with merchants' requirements. For Fiji vegetables there is not a keen demand. Kumalas and tomatoes would, I was informed, probably find a more ready market than at present during the New Zealand "off" season if the quality was of a higher standard but at the same time merchants warned against over production.

11. I concluded my observations and investigations on 10th March, and left Auckland the following day on the s.s. "Aorangi" for Fiji, arriving in the Colony on 14th March.

12. My thanks are due to many business firms and individuals in New Zealand who rendered me valuable assistance during my investigations.

MOULD DAMAGE TO COPRA.

By W. J. Blackie, M.Sc., Government Chemist.

The experimental results in this paper were found scattered through the records of the Agricultural Department and were obtained by the previous Government Chemist, C. L. Southall. The paper in its present form has been entirely compiled by the author who is responsible for the arrangement, introduction, discussion, interpretation of results and graphic representation. From the results and discussion herein described, experiments are now under way to study methods of alleviation of mould action on copra.

INTRODUCTION.

Copra as prepared by the less efficiently equipped producer in Fiji, is attacked by several species of moulds, notably *Aspergillus flavus*, *Aspergillus niger*, *Rhizopus* species and several species of *Penicillium*. The damage caused by these fungoid growths is in many cases quite considerable and the resultant product finds a poor market. Mould action is not confined to the surface nor does copra appear to be limited to the attack of one definite type of mould, but depending upon the season of the year and apparently on the humidity of the atmosphere which controls in no small way the rate of drying, fungoid growths succeed one another in establishing themselves on the drying material. It is usual to find a preponderance of one definite growth at a time although two or three may have succeeded in establishing themselves. The establishment appears, superficially, to follow a definite order in the majority of cases but this is not always so, and in some cases definite growths fail to make their appearance. Under these conditions it is usual to find copra badly attacked, due no doubt to unchecked development of the fungus through lack of competition; and in five or six days the mycelia especially in the case of *Aspergillus flavus* which appears to be responsible for most of the damage, have penetrated into the meat and decomposition ensues, commencing in proximity to the mycelia and gradually spreading throughout the material.

2. It is usual to note that certain types of drying meat are attacked earlier than others, drying under identical conditions. More especially is this so with germinated material and sometimes spore formation has taken place before the neighbouring meat is attacked. The possible explanation here is that enzymic action with consequent decomposition of fats, proteins, carbohydrates has produced a superficial medium suitable both in available food and hydrogen-ion concentration for the establishment of fungoid growths. In all probability the succession of growths is controlled by the increasing acidity of the material which also has its effect on the fungoid lipases and esterases or fat-splitting enzymes since these complex organic compounds, working under optimum conditions, have a fairly narrow P.H. range. Except in the case of the germinated nut, the surface of the fresh meat is neutral or only faintly acid and therefore it is considered that the work of destruction is commenced by bacteria (since bacterial lipase has its optimum at P.H. 7·2 to 9·0), followed by a definite succession of fungoid growths.

Summarising these observations it appears that mould action is influenced by—

(1) humidity of the atmosphere which controls the rate of drying of the meat, and exposure to rainfall;

(2) the preparation of a suitable superficial medium for the establishment of moulds either (*a*) before drying operations as in the case of the germinated nut or (*b*) through the action of bacteria on the copra;

(3) the presence of sufficient moisture in the drying copra to take part in the hydrolytic processes.

3. Little is known with regard to the mechanism of the chemical reactions taking place during the decomposition of copra by bacterial and mould action. When it is considered that the reactions are taking place upon a complex substrate consisting chiefly of complex glycerides, but containing also protein bodies, various types of nucleotides, simple and complex carbohydrates, including cellulose, and various other products in minute amounts, it is readily understood how involved the problem is. The oil extracted from such copra must contain not only the free fatty acids liberated by the action of the lipase group of enzymes but also many other products resulting from the decomposition of proteins, carbohydrates, &c. About twenty-two or more distinct enzymes have been isolated from moulds (many of them from *Aspergillus niger*) and almost as many from bacteria. Among these are lipase, the fat splitting type, various types which act on carbohydrates such as: maltase, raffinase, cellobiase, lactase, diatase, inulase, emulsin, &c.; types acting on nucleic acids, *e.g.*, nuclease and various types such as oxidase, reductase, catalase, all group-specific in their actions. The activity of these various enzymes is dependent in no small manner on the P.H. of the medium, maximum activity being displayed at definite P.H., slight deviations from which have a marked effect and no doubt many of the products produced act as inhibitors of certain types of reaction. The sum total of these different processes is to produce a coloured oil containing free fatty acids, and, as mentioned above, various other products in small amounts. Moreover the oil cake produced has suffered in nutritional value through loss of proteins and carbohydrates. The oil also develops the property of rancidity due both to further decomposition of the acids produced and also to the presence in it of proteins and other decomposition products. Coconut oil consists of mono, di, and triglycerides, of lauric, caproic, caprylic, capric, myristic, palmitic and oleic acids together with small amounts of certain of the esters of phytosterol. With regard to the action of the lipase enzymes on this heterogeneous system, little is known. The composition of the free fatty acids produced has not been determined with any great accuracy. Undoubtedly, certain of the groupings lend themselves more readily to attack than others such as the esters of the unsaturated acids, *e.g.*, oleic, however, although different fats are not attacked at the same rates, owing to the large amounts of lauric acid combinations in the original oil, quantities of this acid would be freed in the oil by enzyme action.

4. In attempting to study the catalytic effects of lipase as a fat splitting enzyme acting on drying copra, one is faced with a varying concentration of substrate, varying hydrogen-ion concentration, and varying temperature. The latter could be controlled and superficially also the P.H. to a limited extent, but variations in substrate concentration and internal P.H. affect the velocity of the enzyme reaction. It would appear also that the accumulation of free acids appears at first to accelerate the reaction of fat splitting, added accumulation of acids slows it down until probably at a definite total free acidity, the enzyme action is destroyed.

This point is illustrated graphically (Graphs 5 and 6), of increase in acidity and logarithum of percentage increase of acids with time. Here it is seen that the amount of free acid reaches a maximum, and then decreases

in value. This decreasing value is to be explained by the utilisation of the free acid by the reverse process of fat formation, or else what appears more likely, their destruction by carboxylase with the production of CO and H_2O. These figures are taken from table (1) and are to be compared with those from table (4) obtained from copra made and stored under commercial conditions.

In graph 6A there is a distinct per cent. increase in acidity up to the 7th day, then a gradual decrease to the 21st day, then a more gradual decrease up to the 28th day. In graph 6B there is a rapid increase up to the 4th day, a more gradual increase from the 4th to the 7th, a more rapid increase comparable with the preliminary stage from the 7th to the 11th day and then a more gradual increase from the 11th to the 14th. This graph is very interesting as it seems to display distinct periods of activity and decline. This either points to (1) definite reactions taking place in order, (2) the establishment and specific action of four different growths, (3) definite equilibria between fat-splitting and acid utilisation. Graph (6C) further amplifies this phenomenon. In this case the logarithm of the per cent. acid increase from step to step is plotted against time. Here it is seen that after the 11th day there is a diminished per cent. acid increase between successive determinations. The four cycles are markedly displayed in this graph.

In order to form some estimate of the damage done to copra by fungoid action the following experiments were arranged and designed to determine the change undergone when copra was exposed to action of various moulds under conditions favourable to these growths.

EXPERIMENTAL METHOD.

Copra was formed from selected mature nuts by sun drying, and the resultant material grated. The meal was mixed thoroughly. The moisture content was determined and a weight equivalent to 15 grams of anhydrous copra weighed into each of 20 petri dishes. The grated copra was then sterilised by superheated steam at 15 lb pressure. Previous experiment showed that this method of sterilisation caused no loss of oil. In order to eliminate variable water content the grated, sterilised material was dried under sterile conditions and the water content of each dish carefully adjusted to 10 per cent. by means of sterile water. Eight of the dishes were then inoculated with a suspension of two species of *Aspergillus* (probably *Asp. flavus* and *Asp. niger*. This diagnosis is only provisional owing to lack of literature to assist identification in the Departmental Library) and *Penicillium glaucum*. The twelve dishes including four uninoculated as controls were placed in a feebly illuminated cupboard.

In order to obtain pure cultures the following method due to Mr. C. H. Wright, a former Government Chemist, was adopted. A sample of badly infected copra was pounded up with sterilised water under sterile conditions and the product used to infect a nutrient agar medium. The growths that resulted were carefully examined and spores from distinct species separated and used to inoculate fresh quantities of agar medium. By several such operations fresh cultures resulted. In order to obtain, as closely as possible, comparative conditions, the following method of inoculating the copra was used. A platinum loop was touched into a mass of spores in the pure cultures and transferred to sterile testubes containing 4 ccs. sterilised water. After thorough mixing one cc. was withdrawn and spread evenly over the copra in each petri dish, one cc. of sterile water without sopres being added to the controls. Necessary adjustments were then made in each case for 10 per cent. moisture content.

Penicillium glaucum did not grow but the species of *Aspergillus* did so luxuriantly during the course of two weeks when a decline set in owing, no doubt, to accumulation of metabolic products. The material was badly attacked by the moulds owing to its physical condition, *i.e.*, increased surface for interaction with the mould enzymes. At the commencement of the experiment the quantity of oil and free fatty acids were determined accurately by analysis of samples from two of the remaining petri dishes also a sample taken from the unsterilised bowl of dessicated coconut. These three analyses gave almost identical results. Two inoculated and one uninoculated dish were withdrawn at the end of one, two, three and four weeks and oil and free fatty acid determined. The oil and free fatty acids were determined in the usual manner and the following results, table (1) obtained:

TABLE 1.

	Copra at Com. Exp.	After 7 days.				After 14 days.			
		Control.	1.	2.	Mean	Control.	1.	2.	Mean
Oil in anhydrous copra %	68·2	68·1	57·7	59·5	58·6	68·1	57·7	52·0	54·9
Acid as oleic in oil .. %	0·3	0·3	5·4	4·9	5·2	0·3	5·1	5·4	5·3
Loss anhydrous copra %	..	..	3·5	3·2	3·4	..	9·0	10·7	9·9
Apparent loss oil .. %	..	..	10·4	8·7	9·6	..	10·5	16·1	13·3
Actual loss oil .. %	..	..	12·5	10·6	11·6	..	15·7	21·7	18·7
Obscured loss oil	..	..	2·1	1·9	2·0	..	5·2	5·6	5·4

TABLE 1—*continued.*

	After 21 days.				After 28 days.			
	Control.	1.	2.	Mean	Control.	1.	2.	Mean
Oil in anhydrous copra .. .. %	68·0	48·8	47·1	48·0	68·2	45·3	49·5	47·4
Acid as oleic in oil .. .. %	0·5	4·1	4·8	4·5	0·4	3·4	3·4	3·4
Loss anhydrous copra .. .. %	..	11·0	16·0	13·5	..	17·3	14·9	16·1
Apparent loss oil .. .. %	..	19·4	21·1	20·3	..	22·9	18·6	20·8
Actual loss oil .. .. .. %	..	24·8	28·6	26·7	..	30·7	26·0	28·4
Obscured loss oil .. .. %	..	5·4	7·6	6·5	..	7·8	7·4	7·6

TABLE 2.

SIMPLYING THE ABOVE TABLE AND TAKING MEAN FIGURES.

Percentage—	*One week.*	*Two weeks.*	*Three weeks.*	*Four weeks.*
Loss anhydrous copra	3·4	9·9	13·5	16·1
Apparent loss oil ..	9·6	13·3	20·3	20·8
Actual loss oil ..	11·6	18·7	26·7	28·4
Obscured loss oil ..	2·0	5·4	6·5	7·6

N.B.—The figures for loss of oil are calculated on anhydrous copra.

On consulting the table, it is to be observed that there may be a variation of as much as 10 per cent. in oil content in anhydrous copra, between the two experimental dishes analysed in each period, probably due to quantity of growth. The mean result is taken in each case and compared with the control which had not varied within the limits of experimental error during the course of the month. The table is self-explanatory and needs no further discussion. Table (2) is a simplification of table (1) taking mean figures.

RESULTS OF EXPERIMENT.

The growth of the two moulds *Aspergillus flavus* and *Asp. niger* on grated coconut containing 10 per cent. moisture over a period of four weeks resulted in—

(1) an apparent loss of 20·8 per cent. of oil, which, corrected for loss of copra, gives an actual loss of 28·4 per cent. oil;
(2) a loss of 16·1 per cent. of anhydrous copra;
(3) an increase in the acidity of oil during the first two weeks of from 0·3 to 5·5 per cent., followed by a decrease in the second two weeks to 3·4 per cent.

2. Concurrently with the above, a second experiment was tried. Copra prepared, shredded, and sterilised as in the first experiment, with its moisture content accurately adjusted to 10 per cent. was exposed on petri dishes for three hours in two bulk copra stores, three dishes in each store. The object of this experiment was to infect copra with spores normally present where copra is stored and to limit the degree of inoculation to a normal amount. After a few days a single mould appeared which seemed to be *Aspergillus flavus* and grew very slowly during the four weeks of the experiment. Control samples unexposed were kept as in experiment (1).

At the end of the period, 28 days, analyses were performed as before and the results are tabulated in Table 3:—

TABLE 3.

	Unexposed.		Exposed copra after 28 days.					
			Store "A."			Store "B."		
	1st day.	28th day.	1.	2.	3.	1.	2.	3.
Oil in anhydrous copra	68·2	68·1	66·7	67·3	64·7	66·9	65·8	66·0
Acid as oleic in oil	0·3	0·4	8·3	7·7	8·4	8·0	8·6	8·6
Loss anhydrous copra	..	..	4·3	3·0	4·1	3·9	3·6	3·6
Apparent loss oil	..	..	1·4	0·8	3·4	1·2	2·3	2·1
Actual loss oil	..	..	4·3	2·9	5·9	3·9	4·7	4·5
Obscured loss oil	..	..	2·9	2·1	2·5	2·7	2·4	2·4

N.B.—The figures for loss of oil are calculated on anhydrous copra.

RESULTS.

1. The actual loss of oil was relatively much less than in the previous experiment amounting to an average figure of 4·4 per cent.

2. The loss of anhydrous copra was much less, amounting to only 3·9 per cent. as an average figure.

3. A very much greater increase in free fatty acid, the average figure amounting to 8·3 per cent.

DISCUSSION OF RESULTS.

1. In considering the first experiment it is to be clearly understood that the results obtained could not be compared in a quantitative way with the results that would be obtained with copra made and stored under commer-

cial conditions. The reason for this is that (1) the density of the material, that is the mass per unit volume, was much less with the grated material than with normal copra.

2. A greatly increased surface was exposed to enzyme action in the case of grated material thus permitting penetration.

3. The cellular structure of the material was largely altered by the grating, thus permitting a more intense enzyme action on fats, carbohydrates, proteins and other bodies contained in copra.

4. The material was sterilised in the first instance and limited to the attack of one definite species of mould.

5. The degree of infection of the mould was much greater than would occur normally owing to unrestricted growth through lack of competition.

6. The moisture content 10 per cent., was initially high. In practice this would be transient since well dried copra averages about 5·5 per cent. in Fiji.

This experiment was designed to obtain the maximum oil loss by providing optimum conditions for mould growth, the moisture content of 10 per cent. being considered favourable to the two species of *Aspergillus*.

In experiment (2) an attempt was made to eliminate the objection discussed in (4) above, by permitting the grated copra to become normally infected with spores present in the atmosphere of the bulk copra stores, but this experiment also suffers both from the objections discussed above and from the fact that—

(*a*) there are very few air-currents present in a copra store, and hence infection by spores is at minimum;

(*b*) several moulds in series had grown on the bulk material during the formation of copra.

Therefore, the type present on the material in the bulk stores had established itself after a series of fungi had interacted with the material and as a result, had become unsuitable for establishment on the grated copra, which had been sterilised and kept free from mould action. This seems to be so from the fact that, although the surface of the grated copra open to interaction was much larger than with normal copra, only one fungus succeeded in establishing itself and grew very slowly during the four weeks of the experiment. From the consideration of the above results it was thought that a fairer estimate of the damage done, could be obtained by determining the losses resulting from copra prepared upon open "Vatas" as practised by producers in Fiji. The intention was to produce copra containing about 10 per cent. free fatty acid, this being the average acidity of Fijian copra, and with this end in view the copra was subjected to somewhat harsh treatment. To prevent evaporation, it was kept covered without much ventilation, when a moisture content of 10 per cent. was reached. This was assumed to correspond to the practice of removing semi-dried copra from the "Vata" to a large heap inside a shed.

DESCRIPTION OF EXPERIMENT.

Eighty-six pounds of fresh cut copra of known composition was spread on a "Vata" protected from rats and mongoose in two separate portions, one containing 50 lb and the other 36 lb. The smaller portion was for the purpose of daily sampling, in order that the approximate condition of the main heap could be determined. Ten pounds of the same copra was dried in a steam oven at about 180° F. Rain fell on the copra for a short time on the 3rd, 4th, 5th, and 9th days. During the night, the material was heaped under galvanised iron.

2. The copra soon became heavily infected with moulds, but they did not penetrate far into the mass until five or six days had elapsed. Mould attack was assisted by copra beetles which, by attacking mouldy spots and making fresh openings, increased the surface of interaction.

3. After fourteen days had elapsed, the copra was dried down to 5 per cent. water, carefully sampled and analysed. The copra prepared in the steam oven yielded the theoretical quantity of anhydrous copra which for the nuts used, amounted to 54 per cent. of the original weight.

TABLE 4.

	Time in days from the commencement of the experiment.							
	1.	3.	4.	7.	9.	11.	13.	14
Loss of anhydrous copra ..	..	0·8	1·6	3·0	5·6	7·4	10·5	12·4
Oil in anhydrous copra	67·6	65·7	65·3	65·7	63·1	62·3	60·7	59·4
Actual oil loss	..	1·9	2·3	1·9	4·5	5·3	6·9	8·2
Free acid in oil (as oleic) ..	0·2	0·8	1·6	1·9	3·3	5·7	7·3	8·5

RESULTS OF EXPERIMENT.

1. The total loss of anhydrous copra was 12·4 per cent.

2. The increase in acidity calculated as oleic acid was 8·3 per cent.

3. The brown mould which appeared in quantity after the fifth day, *Aspergillus glaucus*, appeared to cause the most damage.

4. The experiment appeared to indicate that the main loss takes place not on the "Vata" itself but during storage before the moisture content falls below 6 per cent. If this should prove to be correct a much greater loss of copra than the 12·4 per cent. obtained in the experiment appears to be possible in many of the wetter districts.

SUMMARY.

In the introductory portion of this paper an attempt was made to indicate the complexity of the chemical problems connected with the decomposition of copra, chiefly by mould action. It is only by study in this direction and a thorough mycological investigation that attempts can be made, in an enlightened way, to counteract the destruction. From observations made of commercial samples and as a result of the experiments above described, surmises, at the present juncture, with regard to certain features underlying the *modus operandi* of this deterioration are advanced.

It was therein stated that—

(1) the humidity of the atmosphere controls in no small manner the establishment and development of fungoid growths;

(2) that moulds attack the copra in order and that it is usual to find a preponderance of one growth at a time;

(3) that bacterial activity may be a precursor of fungoid activity. This is contrary to results obtained by others. (See Copeland "The Coconut");

(4) that enzyme action is not alone limited to the destruction of the fats;

(5) that a changing hydrogen-ion concentration controls establishment of moulds and the nature of subsequent enzyme action;

(6) that where one growth preponderates under conditions favourable to it, destruction as measured by the decreasing oil content is generally, other things being equal, at a maximum for the experimental period concerned.

(1) With regard to (1) practical experience has definitely shown that drying-copra, on open "Vatas" unprotected from rain, becomes seriously infected with moulds especially if the humidity of the atmosphere limits the rate of drying. It is quite a common thing to notice that copra which under the influence of a spell of dry weather has developed the crackling sound on fracture, also a clean fracture, becomes quite leathery if the drying conditions are changed by a spell of very humid weather. This flaccid condition is due to the absorption of moisture. If, as some authors go so far as to maintain, that mould action is definitely controlled by the amount of water present (see Copeland: "The Coconut") then a changing water content would have a marked effect on mould action. This, however, is only apparently so, since changing water content would also mean a greater solution and consequent ionisation of free fatty acid with the production of hydrogen-ions which in an unbuffered solution would mean an increasing actual acidity.

It is essential, in order to prevent or limit mould action, to dry the copra as rapidly as possible to somewhere in the neighbourhood of 5 per cent. at least and this is impossible under high humidity conditions on the open "Vata" with inadequate protection from weather. It might be argued here that rain falling on semi-dried copra has difficulty of penetration but it is to be remembered that superficially the water concentration would be high enough for mould activity and that this superficial concentration would be regulated by the humidity of the atmosphere.

(2) Experiments now being carried out have displayed the fact, as far as superficial examination is able to determine, that it is unusual to find under commercial conditions several moulds attacking copra with equal intensity at the one time. It appears more usual to find a preponderance of one growth and in many cases one growth only actively operating. The appearance of another seems to herald the decline of the actively operating type under observation. If, owing to peculiar conditions in different portions of the meat, several fungi have made their appearance, the growth of each is restricted and stunted.

(3) If a careful observation is made of drying meat it is seen, during the first and second day under humid conditions, that a slight browning may take place in some cases. In others differences are noticed in the colour of the meat at definite positions on the surface although microscopic observation showed few spores and those that were present did not appear to be germinating. It would appear from this that the fungoid spores present could not develop until the surface had been changed in some manner for them. Further microscopic observations showed that when the spores developed they did so in these discloured patches. The reason for considering bacteria as a precursor of fungoid action was stated in the introduction. It might be argued that experiment (1) negatives this surmise since infection of a fungoid on sterilised material resulted in the development of the fungoid growth. But it is to be remembered that the fungoid growth was not sterile with regard to bacteria and also that the material infected was already prepared copra and possibly had already, before sterilisation, been subjected to a preliminary bacterial infection, with an accumulation

of products necessary for fungoid development. Instead of negativing, experiment (1) tends to support the surmise from the following considerations. The control dishes, after sterilisation, were placed in the same cupboard and in close proximity to the dishes in which *Aspergillus* species was actively growing. Now these controls under the above-mentioned conditions did not change in oil and free fatty acid within the limits of experimental error during the period of the experiment (one month). It is conceivable that spores must have fallen on this control material and it is reasonable to ask why they did not develop. Apparently, the slight acidity 0·3 per cent. was detrimental to bacterial action or rather for the action of those types present in a chemical laboratory since the material remained sterile, (if sterility can be measured by an unchanged substrate) during the experimental period. The only conclusion to be drawn then is that suitable strains of bacteria or suitable products for germination were introduced with the infection on the experimental dishes. The former view seems more acceptable in the light of experiment (2). Here possibilities of obtaining the right strains of the bacteria would be more limited than under exposed conditions or by direct inoculation and it is to be noted that only a single fungus established itself and grew very slowly during the experiment. However, other limiting features are discussed in the results of the experiment. It will be realised how important the proving of this point would be in the control of growths since by suitably sterilising the material it might be possible to either limit the series of reactions or else prevent them entirely. Experiments are now in progress from these points of view.

(4) It is reasonable to suppose since the fats have a high concentration, in the copra and are in an available form that enzyme action would be concentrated on the splitting of these substances. This may be true but it is not correct to believe that enzyme action is limited to these substances. In this connection the following graphs (1) and (2) are interesting. The values used are taken from Tables 1 and 4.

If the destruction of copra is directly proportional to loss in oil then, if corresponding values of per cent. loss of anhydrous copra are plotted against per cent. actual oil loss then a straight line graph should result. On comparing the two graphs it is seen that this is true for the greater number of values in graph (2) and less accurately in graph (1) which suffers from lack of intermediate values. In both graphs it is to be noticed that in the preliminary stages enzyme action is not limited to the decomposition of the fats. It is noticed in graph (2) after the third day when the free acidity has reached the value of 0·8 and when 0·8 per cent. anhydrous copra has been lost that enzyme action appears to be limited to fat splitting. Graph (1) is not strictly comparable owing to reasons (discussed elsewhere) which may account for the slight irregularities. Again it is noticed in graph (3) that the loss of oil is heavier in the case of experiment (1) yet if the loss in anhydrous copra is compared under the same conditions, graph (4) it is seen that they are comparable up to almost the fourteenth day. This shows that copra is being changed at the same rate but that other enzyme besides the lipase group are actively operating and obscuring results.

(5) The reasons for considering this point as a feature in copra destruction was discussed in the introduction of this paper and no doubt is the main point concerned with the prolonged action of moulds permitting, as it does, attack from various species. Experiments now in the course of progress seem to show that by varying the hydrogen-ion concentration of the superficial medium growth is limited and in one particular experiment, greatly restricted. These experiments will form the subject of a further communication.

(6) On examining graph (3) it is noticed that the per cent. loss of oil as graphed against the time, shows a great difference in the two cases. In that case where only one fungus is grown the loss of oil is very much greater but begins to fall off between the 21st and 28th day. The same type of graph is displayed in both cases but the loss is more gradual with the copra prepared under commercial conditions. Many objections could be raised here from the points of view previously discussed in comparing these two experiments but observations of commercially made material seem to support this contention. From the graphs it is seen that the loss of oil is almost a function of the time that has elapsed up to at least twenty-one days in the case of experiment (1). Experiment (2) was discontinued at the 14th day.

(7) The production of acids in an unbuffered medium would have, in the presence of sufficient moisture, an effect on the hydrogen-ion concentration. This, of course, is qualified by the nature of the acids and their ionising ability. Therefore this section could be discussed under (6) above. In graph (5A) it is clearly shown that the acidity rises steeply then very gradually until, at the 14th day, it begins to decrease and at the 28th day it has a value corresponding to what it was between the 4th and 5th day (from the graph). This condition is not realised in graph B for copra prepared under commercial conditions. The rates of formation of acids is irregular up to the 7th day when the increase is regular to the 14th and is almost perfectly a function of the time. Peculiar features with regard to graphs A and B are that decreasing acidity (5A) does not correspond to increase oil or rather relatively decreasing oil loss nor does increased acidity (5B) correspond to markedly increasing oil loss.

Undoubtedly this phenomonen requires further confirmation. With regard to experiment (1) the nature of the graph would seem to indicate the point mentioned in the introduction that the disappearance of the free fatty acids points to the action of the enzyme carboxylase.

CONCLUSIONS.

When it is considered how varied are the uses of coconut oil both as a food source and in the soap and allied industries it is understood how essential it is to produce as pure an article as possible, both from the point of view of increased returns and also the cheapening of the manufactured article. If it is considered that the total production of copra in Fiji in 1926 was 27,868 tons and if all this suffered a deterioration from mould action of 12·4 per cent. then the loss to producers amounted to at least £70,974 at the then ruling price of £18 per ton. This loss would be even greater in the wetter districts of the Group. This is serious and attempts to remedy the condition are called for. In the foregoing some attempt has been made with the help of experimentally obtained values to discuss this problem with a view to controlling mould growth. This paper was written primarily to stimulate interest in the subject and also as an introduction to work now in progress in which practical attempts are being made to control this loss, notably by a thorough investigation of the claims made for sulphuring copra as a preventive of fungoid action. It is hoped that these investigations will be of use and of sufficient importance to merit further communications. No doubt many of the points raised and the methods of interpretation of results are controversial nevertheless there are certain grounds, if only tentative for the above discussion; and if interest is stimulated thereby then one of the objects in writing this paper has been satisfied. Undoubtedly a thorough mycological investigation is called for since this is a part of the subject that has been neglected.

Much useful work and investigation has been done in the Philippines on this subject but more is required; also conditions are not altogether similar in each country more especially with regard to the types of organisms attacking the copra and also climatic features.

Recently in the British Chemical Abstracts for March, 1930, page 375, several papers dealing with the action of Aspergillus species on synthetic media, &c., are discussed. In Acta Phytochim (1924, 4, 343 361) H. Tamiya and T. Hida discuss in a very important paper the acid production, respiration, oxidase reaction and reducing power of various species of Aspergillus. Unfortunately the original paper is not available and the abstract is rather short. In the (J. Soc. Chem. Ind. Japan 1929, 32, 306B, 307B, 308B) R. Takata considers among other interesting things the reaction between the hydrogen-ion concentration of the medium and the yield of mycelium and the influence of sodium chloride, sodium sulphate and sugar concentration on the growth of the mycelium. He finds:—

(1) that the maximum yield of mycelium is obtained between P.H. 4·5 and 5·6;

(2) that growth is increased by the addition of sodium chloride and sulphate to the medium in definite concentrations.

We have found that washing "meat" with a 5 to 10 per cent. salt solution with the idea of producing the white mould free copra sometimes obtained by drying the material exposed to sea breezes, produced on drying a very mouldy copra which was completely decomposed after two months storage in a sealed specimen bottle. Controls similarly stored although attacked slightly still yielded after the same time a fair quality copra. The complete decomposition of the material appeared to be due to the action of one mould. These results are interesting and again display the fact that the nature of the superficial medium controls the type of organism that can establish itself and develop.

I am indebted to Mr. Surridge, A.R.C.S. (1) Agronomist to the Coconut Committee, for valued criticism and suggestions.

ENTOMOLOGICAL NOTES.

(i) THE CLIDEMIA THRIPS (*LIOTHRIPS URICHI*, KARNY).

By H. W. Simmonds, F.E.S.

A strong colony of this insect was introduced from Trinidad, to be used against the Curse, *Clidemia hirta*. They landed in good order on 13th March and by the 20th, 5,000 adults had been picked off the plants and placed, half in cages for breeding purposes, and half in the open.

It is proposed to breed the insect up and liberate in the various districts as material becomes available. The effect of the insect is to cause a die-back of the terminal shoots, but not to kill the roots. When the insect is well established, planters will still have to clean their land, but it is hoped that it will so far reduce seeding that reinfestation will seldom take place.

THE LANTANA BUG (*TELEONEMIA LANTANÆ*, DIST.).

This bug, introduced in October, 1928, is now well established in the Suva District. Considerable areas show a yellowing of the foliage, combined with a failure to produce flowers or set seed, whilst in some places it has reached the extent of defoliating the plants.

(ii) BIOLOGICAL CONTROL OF SPATHE-BORER, COCONUT SCALE, AND KOSTER'S CURSE.

By T. H. C. Taylor, B.Sc.

The following notes, which are in the nature of an interim report, may be of interest to planters and others who are personally concerned with these pests.

1. CONTROL OF TIRATHABA TRICHOGRAMMA—(SPATHE-BORER).

The parasite imported from Java in March, 1930, to combat *Tirathaba*, which is a serious pest of coconuts on every island throughout Fiji, is now being reared in large numbers in captivity. In Java this parasite attacks *Tirathaba rufivena* and *T. mundella*, two moths which are closely allied to the Fiji species, *T. trichogramma*. The latter species is not present in Java; nevertheless the parasite attacks it with avidity in Fiji.

The parasite is *Apanteles tirathabæ*, a small but very active wasp-like insect. It lays its eggs in young larvæ of *Tirathaba* and the resulting grubs feed on the internal organs of the larvæ and kill them after about ten days.

Many difficulties were experienced when the parasites were first imported into Fiji, chiefly owing to the necessity for quarantine for cholera, and the work of distribution has been greatly delayed in consequence. In the latter part of April, however, three colonies were liberated, one at Nasese, near Suva, chiefly for observation purposes, another at Muanicula, Wainunu, and a third in Taveuni, and it is thought that about four colonies will be available for liberation every month from May onwards.

The importation of this parasite, which was the result of the researches of Mr. Paine in Java, marks an important stage in the attempt which is being made to control *Tirathaba* in Fiji. The problem is not so simple as in the case of the Levuana Moth or of the Coconut Scale, both of which now appear to be satisfactorily controlled, but it is hoped that similar results will eventually be achieved in the case of *Tirathaba*. It may, however, be necessary to supplement the activities of the recently imported parasites by importing other species later in the year.

2.—ASPIDIOTUS DESTRUCTOR—(COCONUT SCALE).

A brief inspection of Muanicula Estate on the Wainunu River was made on 30th April, 1930. Large areas on this estate were very heavily infested with scale until 1928, when colonies of the Coccinellid beetle, *Cryptognatha nodiceps*, imported from Trinidad, were liberated. The beetles multiplied extraordinarily rapidly, and early in 1929 the infected coconut palms were all covered with them, so much so that the beetles and their larvæ could easily be seen from the ground on the leaves of the smaller trees.

The scale has now entirely disappeared from all parts of the Muanicula Estate and throughout the Wainunu district. Further, the beetles were liberated at about the same time in all parts of Fiji where scale formerly abounded, notably in the Lomaiviti Group and in the Savusavu district, and in all cases their liberation was followed within a year by the disappearance of the scale.

3.—CLIDEMIA HIRTA—(KOSTER'S CURSE).

Considerable progress has been made in connection with the distribution of the insects imported from Trinidad in the middle of March, 1930, to attack the weed, *Clidemia hirta*.

The insects in question belong to a peculiar group known as Thrips. Their technical name is *Liothrips urichi*, Karny. They are extremely small and are not readily seen with the naked eye. The adult insects are black and of an elongated, torpedo-like, shape. The immature stages are similar in shape to the adults but are bright red in colour, and therefore easily distinguishable from them.

The nature of the damage done to the plants is very apparent in the cages in Suva in which the thrips are being bred. The young leaves at the tips of the branches are attacked first. The insects live entirely on the undersides of the leaves and on the stems, and feed by puncturing the plant tissues, which turn black in the vicinity of each puncture. The resulting black spots are readily apparent on the plants. The attacked leaves and stems soon die and the leaves drop off. The plants are greatly weakened in consequence of the destruction of all the young shoots. In captivity the insects are capable of completely defoliating the plants and killing them outright.

Many large colonies of the trips have already been liberated in the Tailevu district, and others at Nasinu and Lami. In Taveuni three colonies have been liberated, and one at Muanicula, Wainunu. Arrangements are being made to send infected plants to Navua at the beginning of May and others to the Rewa district soon afterwards.

In view of the widespread interest and optimism which have been shown in the activities of these insects it must be pointed out that in spite of their very satisfactory behaviour in captivity no immediate results can be expected on a large scale in the field. Moreover, the work must be regarded purely as an experiment, which is as likely to fail as to succeed. There is now little doubt that the thrips will become established in Fiji, but the areas in which *Clidemia hirta* flourishes are so vast that it will be many months if not years, before the insects multiply and distribute themselves sufficiently to bring about even a partial control of the weed. And at the present stage in the work it is impossible to predict whether they will ever effect an appreciable control.

PRESERVATION OF BOOKS IN THE TROPICS.

By W. J. Blackie, M.Sc., Government Chemist.

A great deal of damage to books and documents results from the united action of insects and moulds. The worst insect offenders in Fiji are undoubtedly the beetle borer and the cockroach; these, by boring or gnawing the covers and printed pages, destroy the book both in appearance and usefulness.

2. In the Agricultural Department many valuable textbooks to which constant reference is being made, also many of the current journals, have been seriously attacked in the past and therefore our endeavours to build up a useful reference library is largely vitiated by the increased cost attending replacement of destroyed volumes. In many cases scientific papers of value, many of which are complimentary copies, cannot be so replaced.

3. In order to minimise this deterioration it is essential—

(1) that the bookcases be closed by tightly-fitting glass doors;

(2) that the air of the bookcases contain the vapour of some volatile chemical deterrent;

(3) that the volumes themselves be treated with some poisonous material which, having no action on the books, prevents insect and mould destruction.

4. With these objects in view the following procedure has been adopted. Two solutions containing the following ingredients were made up:—

Solution (*a*) contained 1 oz. corrosive sublimate, 1½ oz. carbolic acid and one-quart of methylated spirits containing pyridene as one of the denaturing agents.

Solution (*b*) contained 1 oz. of shellac dissolved in 8 ozs. of methylated spirits to which was added 3 drms. of creosote oil.

6. The books were first fumigated with hydrocyanic acid gas to kill spores, &c., then with a flat brush, solution (*a*) was painted on to the covers, inside and out, and generously along the seam dividing the cover from the printed material. After drying, which is quite rapid, the varnish (*b*) was painted on in a similar manner a slight smear being also added to the extremities of the pages, while the book was closed. On drying, the book has a varnished look which does not detract from its appearance. Solution (*a*) must be continually stirred during painting operations in order to obtain an even mixture of corrosive sublimate which has a tendency to settle out.

5. The shelves of the bookcase are also similarly treated with solutions (*a*) and (*b*), and after placing the books back in the case procelain dishes containing paradichlorobenzene are added. A better procedure here would be to drill holes in the shelves at regular intervals and sink in suitable metallic containers for the paradichlorobenzene.

6. For facilitating storage and availability, scientific papers and pamphlets are kept in springback cardboard holders of the box variety. These are treated similarly by painting inside and outside with solutions (*a*) and (*b*) and an envelope containing paradichlorobenzene deposited conveniently inside or fixed with gum to the inside of the lid.

7. This would be a very convenient method for storing and preserving valuable Government documents and Minute Papers.

8. The above described procedure has been only recently adopted but the results attending the use of solution (*b*) by the Veterinary Department have been markedly successful.

9. With regard to frequency of treatment, little can be said as yet, however, once a year should be sufficient.

10. It is necessary to close the bookcase directly after removing or replacing a volume.

GRASSLAND ITS TREATMENT AND MANAGEMENT.

By R. Lindsay Robb, N.D.A., N.D.D., Imperial Chemical Industries Ltd.

PART I.—ESTABLISHMENT OF NEW PASTURES.

POINTS TO AVOID IN PASTURE ESTABLISHMENT.

The most common causes of disappointment in pasture establishment are due to—

(1) using seed mixtures unsuited to the local conditions;
(2) sowing unsuitable strains of plants;
(3) failure to rid the soil of excess moisture;
(4) sowing seeds on weed infested land;
(5) endeavouring to establish a pasture on land "worn out" by continuous cropping without manuring.

All pasture plants may be classified into groups or associations, and each association has a clearly defined set of conditions necessary for development. For successful establishment, therefore, an "association" must be sown to suit the local soil conditions.

The main consideration is the establishment of a sward composed of plants which may thrive under conditions as they exist. This, in all probability, is merely the foundational stage in the development of a future productive pasture and should only be regarded as such.

It is quite futile to attempt the formation of good pasture on water logged land, and money spent on seeds and manures is simply wasted until the excess moisture has been removed. Admittedly draining is a costly operation, but if land is water logged, the ever-recurring expense of seeding and manuring cannot be remunerative until the cause of the trouble—excess moisture—is removed.

CLEAN SEED BED.

The importance of clean land cannot be over-estimated in laying down land to grass. The weed competition may be serious enough for the first year or two on land which appears to be reasonably clean, but where conditions have not permitted of thorough cleaning prior to sowing the seeds, there is a very real danger of the weeds gaining the upper hand before the legitimate plants have been able to establish themselves. Land which may have been continually "white" cropped for a number of years without adequate manuring, always presents serious difficulties for good pasture establishment. The standard of fertility is low, and weeds adapted to this condition generally abound. Thorough cleaning and very generous manurial treatment are essential if a good pasture is to be obtained under such conditions.

VALUE OF SOWING PERSISTENT STRAINS.

Assuming that the land is clean and in good heart, it is important to secure strains of plants which are productive and highly persistent. The leaf is the richest and most nutritious part of the plant.

MANURING WHEN LAYING DOWN.

Liberal manuring of newly laid down pastures is highly important right from the earliest stages of development, and, where practiced, may permit of the establishment of high fertility demanding plants like perennial rye-grass and white clover under comparatively low standards of soil fertility. The importance of persistent strains of plants cannot be over-emphasised, as their response to and development by manurial applications is such, that the cost of manuring is relatively much less than on pastures comprised largely of short-lived and unresponsive plants.

PART II.—MAINTENANCE OF ESTABLISHED PASTURES.

SECONDARY GROWTH.

Large areas of grazing land in New Zealand are not giving of their best, because of the invasion of secondary growth. To effectively deal with this menace is extremely difficult, especially where the value of the land does not permit of much economic expenditure on labour and stock. The more extensive use of cattle to eat down the rank growth along with subdivision, and the use of suitable fertilizers to improve the quality of the herbage offers, perhaps, the most effective means of combating this difficulty.

DRAINING.

The need for removal of excess moisture has already been alluded to in Part I. There are, however, large areas of established pastures of comparatively low productivity because the land is in need of draining. Wet land encourages the growth of weeds and non-nutritious plants of an unpa-

latable nature; spring growth is delayed and grazing during the wetter part of the season is very difficult on account of the hoof damage done by the stock. Draining is often the means of converting this poor grazing land into highly productive pastures, and unfortunately, until this is done, the grazing value is almost negligible. The clearing of ditches and water furrowing in some cases will, to some extent, minimise the losses on poorly drained land. One of the most important features of drainage is to allow for heavier intermittent stocking to be carried out. The land, in an undrained condition is perhaps capable of producing an abundance of grass, but its utilisation becomes a matter of the greatest difficulty. Heavy stocking of wet land often results in the ruin of the pasture.

GRAZING AND MOWING.

While young pastures should not be too severely grazed in their early stages of development, the over-grazing of rapidly growing grass on established pastures, under high fertility conditions, is hardly possible, but may easily take place when fertility factors are not continuously high. The old method of leaving too much grass unconsumed during the late summer and autumn to supply winter grazing is not to be recommended, as the quality of the feed is extremely low and the rough grass suppresses and delays the new growth in spring.

Mixed grazing or grazing different types of stock over the paddocks keeps the pastures in better condition than grazing with one class of stock only. Horses are very selective in their grazing and the herbage soon becomes rough and tufted when they are the sole grazing stock. Sheep are also selective grazers, and confine themselves entirely to the short fine plants, whereas cattle are much less discriminating in their choice of the herbage plants.

As grass is nutritious in direct proportion as it is young, immature, and the product of rapid growth, the feeding of pastures when the herbage is short cannot be too strongly recommended, but this aspect of the question is more fully discussed later under intensive management.

If the stock cannot utilise all the grass, the mowing machine should be used to remove the surplus growth before any deterioration of the herbage takes place. By this means, the finer bottom grasses and clovers may develop freely when otherwise they may be suppressed almost to the point of extinction.

HARROWING.

The possibilities of effecting improvement in the pastures by more extensive use of the right type of harrows are very great. The chain harrow is useful for spreading animal droppings during the grazing season but quite ineffective as a cultivator. A severe tine harrow during the autumn or winter will assist in the removal of unconsumed grass or dead matter which may have accumulated, and will also improve the aeration of the soil. This greatly facilitates the action of any fertilisers which may be applied rendering them much more effective than if applied on rough unharrowed land. During recent years stronger and better types of harrows for grassland have been evolved and they are proving of great value throughout the grazing areas. The degree of severity of harrowing which is necessary will naturally vary according to the age of the pasture, the efficiency of past grazing, the amount of "dead" growth and condition of the turf.

CONSOLIDATION—HOOF CULTIVATION.

The improvement effected by the consolidation of grazing stock or "hoof cultivation" has often been very marked on grassland throughout

New Zealand. This has been specially noticeable on phosphatic topdressed pastures of the poorer types. The consolidation effected by the treading of the animals appear to facilitate root development of the herbage plants and finally produces a sward of pleasing density. An occasional rolling of the pastures is highly beneficial, but to be effective it must be done when conditions are suitable.

FENCING.

Proper and adequate fencing is a very substantial aid to the securing of maximum returns from grassland. Closer subdivision is urgently required on many areas in order that the grazing may be better controlled. When subdividing, it is advisable to fence, as far as possible, land of the same type. Various types of pasture in the same paddock are not conducive to efficient grazing. The question of fencing is more fully discussed in Part III.

LIMING.

Lime deficiency is one of the most serious limiting factors in the production of good grassland in the Dominion. Fortunately the practice of liming pastures is extending, but the rate could be greatly accelerated with advantage. Soil acidity and lack of lime, limits the species of pastures plants that thrive on any particular area. Further, those that thrive, are not so nutritious as they might be.

Even when lime does not materially increase the bulk of herbage on grassland, it usually beneficially influences the quality. The lack of response of many soils to phosphatic manuring is due to lack of lime. When there is no response of clovers to soluble phosphates, an application of lime should be tried. Even on limestone soils, a surface application of lime is often profitable, as the lime "in situ" may be too deep to sweeten the surface soil layers. Where intensive manuring is practised, liming should be carried out at suitable intervals. The effect of liming pastures reacts beneficially on the health of livestock. Ground carbonate is the popular form of lime to apply. The finer the grinding and the softer the lime, provided the analysis is high, the better. From 10 to 20 cwt. per acre of ground carbonate is a usual dressing, and the autumn and early winter is the best time to apply it. Limited pastures are more drought resistant than grassland which has not been limed, the clovers particularly and also the grasses making better growth during the dry period than on the unlimed area.

TOPDRESSING WITH PHOSPHATES.

Although in recent years there has been a big expansion in the topdressing of pasture lands with phosphatic manures, there is ample room for an extension of this commendable practice. New Zealand soils are short in phosphates, and there are few areas that do not repay an application of phosphatic manures. On many soils the stimulation of grasses, and particularly clovers, with a manure like superphosphate is indeed remarkable. Fortunately, not only is the quantity of herbage increased, but the quality is greatly improved. The better types of grasses thrive at the expense of the coarser species under topdressing, while the health of stock is generally improved, such complaints as bone-chewing being eliminated. From 2 to 3 cwts. per acre—in some districts twice a year—of superphosphate, is a popular dressing.

In certain districts, basic slag gives good results, and in recent years there has been an expansion in the use of Ground Rock Phosphates.

As to time of application, the tendency almost throughout New Zealand, but more particularly in the North Island, is to make the application of phosphates in March–April, so as to increase the autumn and early winter growth

of the pastures. A growing tendency also is to put on a second application in the spring. Where the summer rainfall is satisfactory, a late spring, or even early summer, application is being favoured nowadays to stimulate the growth of the pasture over the difficult December, January–February period. At this time of the year, a soluble phosphate, such as Super, is usually applied.

Topdressing with phosphates has been extended to the hill country, and, if the pastures of New Zealand are to be maintained in a profitable condition, the use of phosphates on grassland must continue to increase in intensity.

THE PLACE OF POTASH.

Potassic manures are annually growing in popularity in New Zealand. In some parts, such as Southland, their use has shown a very marked increase in recent years. Parts of the North Island, particularly peat swampy areas, *e.g.*, Taupiri in the Waikato, need potash also.

Intensive manurial trials, particularly under the new system of grassland management, will doubtless reveal many areas where potash manures can be profitably used in conjunction with other types of fertilizers. Light sandy and peaty soils are frequently deficient in potash.

Potash aids clover growth, and assists pasture plants in the dry periods. In some areas it is noticeable that stock more closely graze the parts of a pasture treated with potash.

The usual form for pasture is 30 per cent. potash salts and from one to two cwts. per acre can be applied.

PART III.—INTENSIVE MANAGEMENT OF GRASSLAND.

Grassland management has too long been regarded merely as a proposition of topdressing and the movement of stock.

It is not that these factors are in themselves unimportant, but they are hopelessly incomplete where maximum economic production is—or should be—the object in view.

The real aim in pasture management may be summed up briefly as the maximum production of herbage of the highest possible quality and its most complete utilization on the farm. This may be a difficult ideal to attain, but in a country like New Zealand where the chief raw material—and source of wealth—is grassland, it is an ideal which every farmer should keep constantly before him.

The main difficulties of the grassland farmer are, first of all, that he has more grass at certain periods of the year than his stock can consume, and secondly, too little at other periods to meet the stock requirements. The stock-carrying capacity of any farm is based on the number that can be carried during the lowest period of grass production, with the result that, during periods of abundance, the pastures are hopelessly undergrazed and the herbage rapidly deteriorates in quality.

New methods of pasture management known as the "New System" have been in operation in Great Britain and Western Europe for some years. This system has as its aim the ideals already referred to regarding production, quality and utilization of the herbage. It introduces several new features and may be regarded as a combination of the following:—

(1) Complete balanced manuring.
(2) Controlled rotational grazing.
(3) Systematic cultural treatment.
(4) Maximum conversion of herbage into animal products with all surplus made into ensilage and hay.

The system is based on sound scientific principles. Short young grass is richer in digestible protein and minerals and of higher feeding value than grass which has been allowed to grow long. By keeping the herbage consistently short and young, the high feeding value may be maintained throughout the whole season.

One of the vital factors of the system, therefore, is to maintain the pastures in their young and leafy state at all periods of the grazing season. This can only be done under a system of intermittent or rotational grazing and "spelling" and by the appliation of suitable fertilizers.

In order that the herbage may be utilised most effectively it must be consumed fairly quickly when it is very short as it will rapidly advance in growth to a less nutritious stage of lower protein and higher fibre content with decreased palatability. For efficient consumption of herbage relatively large numbers of stock are necessary on comparatively small areas, the stock being moved round the paddocks in rotation.

ROTATIONAL GRAZING.

It is clear that the adoption of intensive methods may necessitate a certain amount of subdivision of large areas into smaller paddocks and this is an important consideration, in view of the cost involved.

Control of grazing may, however, be regarded as the master factor in grassland management, and any expense incurred in the erection of fencing to secure this necessary control will be more than justified by the results The size of a paddock under intensive management is really more a question of numbers of stock than actual acreage. The question of acreage is immaterial so long as the area to be grazed bears a proper relationship to the number of grazing animals. For New Zealand conditions it would appear that the relationship of land to stock (cattle) is twelve to fifteen cows per acre with a sufficient number of paddocks to form a complete grazing cycle.

Thus, on a dairy farm of 30 cows with a carrying capacity of one cow per acre, twelve two-and-a-half acre paddocks would be the ideal number. This, however, may be taken as a guiding figure and might have to be slightly modified according to special climatic conditions and composition of the pasture sward.

This question of size of paddock is of much greater significance than it appears on the surface because the principle of half the number twice as large having the same capacity as double the number half the size does not apply under intensive grazing. In other words, ten paddocks of three acres each have a greater stock-carrying capacity than the same area in five paddocks of six acres each. This has been shown conclusively on a number of farms by the increased grazing obtained after subdivision.

The grazing rotationally of small areas by relatively large numbers of stock necessitates frequent movement of the animals and this movement must take place before there is any decline in the milk yield. A three-acre paddock may carry 40 cows for two or three days, but a six-acre paddock will not carry the same stock for double this period because the wastage of herbage due to trampling, fouling, &c., is relatively higher in the larger paddocks.

It is important therefore, where any subdivision is contemplated, to keep closely in view the ultimate maximum stock-carrying capacity and arrange the size of the paddocks accordingly. For New Zealand conditions the number of cows divided by fifteen (intensive carrying capacity per acre) will usually give the acreage of the paddocks, *e.g.*, 60/15 cow farm equals four acre paddocks.

If the stock-carrying capacity over the whole area was one cow per acre under a more or less continuous system of grazing, the fifteen-four acre paddocks here, under systematic rotational grazing, would provide in addition some ensilage and hay.

LAYOUT OF PADDOCKS.

The "layout" of paddocks for intensive management is important and the aim should be ease and economy of labour in moving the stock. The ideal arrangement is the double line of paddocks with a central "race" which should be of sufficient width to obviate any undue risk of "puddling" or "poaching" by the treading of the animals during wet weather. For reasons which are discussed later, it is advisable to have communicating gates between the different paddocks.

It is not advisable of course to subdivide the whole farm at once but to do so gradually as experience proves the value of the smaller areas and more effective control of the grazing. Thus by the time the whole or greater part of the farm is closely subdivided, the experience gained in the intensive management of a few small paddocks will be of inestimable value when the larger number are brought into the scheme.

WATER SUPPLY.

A supply of wholesome water is essential for grazing stock if the best results are to be obtained. Substantial economies can often be effected in the laying on of water by arranging any necessary subdivision to utilise existing supplies and making one trough suffice for two or more paddocks. Where natural supplies are unavailable an endeavour should be made to equip each paddock with water in order to facilitate the control of the grazing. Many pastures carry an inferior type of sward because they can only be grazed at certain periods when the stock can have access to water supplies.

THE PLACE OF NITROGEN IN MANURING OF GRASSLAND.

Owing to its frequent misuse in the past, nitrogen, until comparatively recently, was not regarded with favour as a fertilizer for grassland. The reason is not difficult to explain. Nitrogen is only one of many constituents which are essential for the growth of all farm crops, of which the most important in New Zealand is grass. There are, however, other constituents which are equally necessary for the growth of plants and the most important to the farmer, in addition to the nitrogen, are the phosphates, lime and potash. Nitrogen is, however, such a dominant factor in plant growth that if applied alone it will increase the yield of a crop.

Its continued application alone, however, over a period of years and the increased yields produced by its stimulation will ultimately give riase to a condition of soil in which one or more of the other essentials (phosphates, potash and lime) are so deficient that satisfactory growth becomes impossible. The strength of a chain always depends on the weakest link and so also does the yield of any crop depend on the essential for growth which is present in the smallest quantity.

BALANCED MANURING.

The fundamental principles of manuring are the maintenance of the balance of lime in the soil and the application of phosphates, potash and nitrogen in forms and quantities and at suitable periods which ensure maximum economic returns without any injurious effects to the soil.

It is clear therefore that nitrogen should not be used as the sole fertilizing ingredient, but in combination with phosphates, potash and lime, as

all four are being continually removed by the production of milk, meat, mutton and wool, and consequently all must be returned to the soil if fertility and high production are to be maintained.

It is not necessary, however, to apply phosphates, potash and lime at the same time as a dressing of nitrogen is given. As a matter of fact, it is often advisable to apply the mineral manures (phosphates, potash and lime) at different periods to that of nitrogen.

The application of nitrogen by itself must not be confused with applying nitrogen alone. Nitrogen alone means its application without phosphates, potash and lime, which is fundamentally wrong, but nitrogen by itself may be highly advantageous so long as the phosphates lime and potash have already been applied.

Phosphates, as already indicated, have played a wonderful part in improving the grasslands of New Zealand and in raising the standard of production.

THE ROLE OF NITROGEN.

Can nitrogen, in addition to the other necesssary mineral manures, still further increase economic production in New Zealand? This question is of great importance to the Dominion farmers and the answer is being sought in the numerous manuring and grazing trials which are being conducted in New Zealand by the Department of Agriculture. From the work already done, there are indications that nitrogen, judiciously used, may become a factor of great importance in the economic development of the grasslands of this country.

IMPORTANCE OF EARLY SPRING GRASS.

Under existing conditions throughout the Dominion, the grass available during the months of August and September is generally insufficient to provide for full yields of milk, and in many cases it is largely utilised, not in the production of butter fat, but in building up the constitution of the cows. This is especially the case where the cows come down to calving in poor condition. For high production, early calving, constitutional fitness at time of calving, and ample grass supplies at the beginning of the lactation are essential conditions.

Early calving appears to be an essential condition to high butter fat production. The two opening months (August and September) probably constitutes the most important period in the whole lactation, and this period at present is one of comparatively low production. If cows are reasonably fit when they calve down at the end of July or beginning of August with plenty of grass available for full yields of milk, the total production per cow would be greatly increased. Better winter feeding is of course absolutely necessary if full yields are to be obtained from the beginning of the lactation.

From experience already gained in the more intensive management of grassland, it is perfectly clear that efficient control of the grazing leads to a complete elimination of pasture weeds. The fact that all herbage is consumed (or mown off) when it is short, prevents the seeding and consequent spreading of weed plants which tend to overrun many "continuously" grazed pastures at present. The beneficial results of this greater weed control are very significant as the legitimate plants have not only greater freedom for development, but also benefit from the extra food material in the soil which was formerly utilised by the weeds.

TIME OF APPLYING NITROGEN.

Because of its possibilities in increasing the growth of grass in August and September, nitrogen is likely to become a factor of great importance on the dairy farming of New Zealand. For this purpose, the indications are that it should be applied as a straight dressing during the month of June or early July after the necessary mineral manures have been applied. The month of July and early August is probably the period of the year when it is most difficult to induce growth because of the naturally unfavourable conditions. It is important, therefore, that the dressing of nitrogen given should be sufficient for the purpose required, and from experience already gained it would appear that from 1½ to 2 cwts. per acre of sulphate of ammonia, or its equivalent in any other suitable nitrogenous manure is about the right apount at this stage.

It is difficult to lay down any hard and fast rules regarding the application of sulphate of ammonia for the purpose of securing an "early bite." The normal period of spring growth varies with different districts and it may even vary on different farms in the same district, depending on the soil and the composition of the pasture sward. For instance, on dry land, the spring growth is earlier than on land even in the same locality which becomes waterlogged during the winter months.

As a guide to the time of applying nitrogen, the following procedure may be of interest. If the spring growth of grass on a particular paddock normally occurs in early September and early grass is wanted by the beginning of August, sulphate of ammonia can be applied from the middle to the end of June. On the other hand, if the normal first growth occurs in October, an application of sulphate of ammonia may be applied with advantage in early August to bring forward the grazing to September.

It is clear that a small dressing applied when conditions for growth are unfavourable, may produce very little result, whereas the larger dressing suggested is likely to produce an excellent growth of grass when it is most difficult to secure and consequently of greatest value on the farm.

During the months of October, November and December, the natural rate of growth is sufficient to produce all the grass necessary without any artificial assistance, and the problem then is one more of utilisation than production.

In January and February there is generally a period of comparative scarcity of grass due to the rapid decline of growth through lack of moisture. How far can nitrogen, if at all, increase the grass growth during this period? A definite answer to this question cannot be given until further experimental work has been done. The limiting growth factor at this stage of the season is generally moisture supply, and the question of increasing the production of grass by manuring is more speculative than at other seasons of the year when the rainfall is more reliable.

CONTROLLED GRAZING.

One of the chief problems, and perhaps one of the greatest difficulties in the management of grassland, is that of controlling the grazing, and failure in this respect has been responsible for the ruin of many pastures. If the grass growth was more or less uniform throughout the season, the control of the grazing would be a comparatively easy matter, but unfortunately this is not the case, and of course, it is quite impracticable to vary the numbers of stock according to the amount of feed available at different periods of the grazing season.

The question of regulating the supplies of grass throughout the year, by increasing growth during periods of low production, has already been discussed, and there are certainly distinct possibilities in this direction. The higher the stock-carrying capacity can be raised during the winter and early spring months, the less difficult it becomes to control the wealth of feed produced during the "flush" period later in the season.

It is important that each paddock should be grazed bare in turn, as any grass left uneaten is not only lost from a grazing point of view, but it retards the continued development of fresh and succulent herbage. To facilitate clean grazing, the paddocks should be stocked when the grass is very short.

It is important to realise that, under intensive management, short young grass is a "green concentrate" rich in minerals, and should therefore be converted into animal products as far as possible. In other words, the wastage due to treading, fouling, &c., should be reduced to the minimum.

"ON" AND "OFF" METHOD OF GRAZING.

The ideal method of grazing is accomplished by moving the animals in such a way that the maximum use is made of the herbage with the minimum of trampling and fouling. After about one and a half hours' grazing in the morning, the dairy cow has consumed sufficient for her immediate requirements, and she then lies down to rest and ruminate. The wastage due to the cows lying on good grass is very considerable, apart from the fouling of the pasture when the animals rise again. They should therefore be moved on to a well grazed paddock just before they would lie down to rest. After mid-day, they would again go into the "feeding" paddock for an hour or so and then back again to the well grazed resting paddock. After the evening milking, they would again have an hour and a half to two hours in the "feeding" paddock prior to being moved to the resting (bare) paddock for the night.

This suggested system of grazing explains the need—referred to previously—for having communicating gates between the different paddocks. A certain amount of labour is of course involved in the carrying out of the "on and off" method of grazing, but the stock-carrying capacity is increased by the more efficient rationing of the feed, and hence its more complete utilisation. It is a system which should appeal to those who favour the "night" paddock, as any paddocks convenient to the milking shed may be used to serve as "resting" paddocks.

GRADING OF GRAZING STOCK.

Another method of grazing which is favoured is that of grading the stock into two lots according to their economic importance. On a dairy farm, the milking cows take precedence in the grazing scheme, and as soon as a paddock can no longer maintain the milk yield, they are moved on to a fresh one and their place taken by dry stock—uncalved cows, heifers, &c.—which follow up and complete the grazing. The light harrowing to spread the animal droppings during the season, should be done as frequently as necessary.

In this way, the paddocks are grazed and "spelled" in rotation, and while it is a great improvement on the old method of continuous grazing, it does not permit of the same degree of efficient rationing or so complete utilisation of the feed as the "on and off" method.

UTILISING SURPLUS GRASS.—ENSILAGE.

During periods of abundance of feed, the stock available may be incapable of utilising all the grass. These are critical periods of the grazing

season because failure to remove herbage not required by the stock will result in rapid deterioration of the pastures. The clovers and finer grasses become suppressed by the rapid-growing stronger species, and the result, after a period of bad management, is a rough "open" type of pasture with the ultimate elimination of the leguminous plants.

The obvious remedy is to remove the herbage before it reaches this stage and make it into ensilage or hay. By so doing a valuable foodstuff is conserved for use during periods of scarcity and the pasture remains in excellent condition.

In any case it is essential to make provision against possible prolonged droughts or other abnormal conditions, and the conversion of the surplus grass into ensilage is undoubtedly one of the best means of storing up this necessary reserve.

"CATCH" CROPS UNCERTAIN.

The growing of supplementary catch crops to provide "feed" during low periods of grass production is one of doubtful economy. The labour involved in the production of these crops is expensive and moreover they are seldom ready for use just when they are most required.

(From "Grassland, its Treatment and Management" by R. Lindsay Robb, N.D.A., N.D.D., Imperial Chemical Industries Ltd.)

NOXIOUS WEEDS.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E.,
Superintendent of Agriculture.

THE problem of controlling the growth of noxious weeds is increasing in importance. Agricultural operations in Fiji, whether conducted by Europeans, Fijians, or Indians, involve a continuous struggle to combat the inroads of such objectionable plants as Koster's Curse (*Clidemia hirta*), Lantana, and Prickly Solanum (*Solanum torvum*). Even on lands under continuous cultivation the menace is serious, but when pasture lands, and rich areas of undeveloped country are seen to be heavily infested with these plants, it cannot but be realised that an early and determined effort is necessary to secure some measure of control. For years it has been known that this question must be tackled in no uncertain manner, and though sporadic efforts have been made; though legislation has been resorted to; and much time and effort spent in various directions, still the areas covered by noxious weeds go on increasing.

Development of the dairying and stock-raising industries is being retarded and the costs of maintaining arable land in cultivation are increasing. Production is held in check and the agricultural community views with dismay the luxuriant growth of noxious weeds. The weeds flower, seed, and spread, practically unchecked by enemies of any kind whatsoever. Occasionally one sees patches of land where the careful work of years has rendered the weeds less obtrusive and in properly cultivated areas, particularly those cropped by the Colonial Sugar Refining Company Limited, and its tenants, they are perhaps of minor importance owing to the system of cane cultivation practised.

The noxious weed problem is by no means new in the Islands of the Pacific. Darwin in "The Voyage of H.M.S. 'Beagle,'" recorded the spread of imported guava in Tahiti to such an extent that it became an objectionable weed a century ago.

Much is expected from the importation of a thrips from Trinidad to control Koester's Curse. We must, however, patiently await the results of the trials, and even these, if successful can lead but to a retardation of the spread of the plant for some time, though we may reasonably hope for a diminution of its incidence in a few years. Doubtless biological control will be an important factor in checking the growth of this weed, but complete eradication is, it is feared, too much to anticipate.

Let us then ask ourselves what are the possible methods of controlling and reducing the incidence of the noxious weeds of Fiji? The following suggest themselves:—

(1) Complete clearing followed by cultivation; applicable to land intended for periodical cropping.

(2) Clearing, cultivation and grassing, with the periodical cutting by hand or machine of noxious weeds in the early stages of growth; as on pasture lands.

(3) Biological control. This has yet to be tested and in any case is not likely to remove the obligation upon the land worker of initial clearing of weeds.

(4) Prevention of seeding of weed plants by slashing before they flower on uncultivated lands not used for pasturage.

(5) Suppression by use of cover crops of a beneficial kind.

(6) The use of weed killers.

Experimental investigations are being carried out by the Department of Agriculture, but these need time to attain a stage when definite instructions in regard to any given local conditions can be given. There are, however, numerous planters and stockmen who have themselves dealt with the noxious weed problem on their land, in many cases with considerable success. These persons are now requested to record their experiences for the benefit of others. The matter is of such grave importance that it is felt that all who may have attempted to solve the problem for themselves whether successfully or otherwise, will readily state their experiences in the realisation that the menace must be co-operatively grappled with if it is to be combatted with success.

A questionnaire is attached for the guidance of those interested. It may be returned completed, or a brief statement forwarded instead. The object is to endeavour to evolve a cheap and effective means of controlling the various noxious weeds throughout the Colony. Climate and soil differ widely in the Group and methods applicable to one plant or one set of conditions may not be suited to others. Suggestions whether based on experience or not will be welcomed, as also will references to literature in the subject of weed control.

I confidently appeal for the assistance of the whole of the European agricultural community, in the first instance for the collection of information and later, when definite plans have been formulated, for a determined co-operative effort directed towards the control of noxious weeds. Any person who desires that his name be not published in connection with the information he supplies is assured that his wish will be respected.

Replies should be addressed to the Superintendent of Agriculture, Suva, and should be plainly marked "Noxious Weeds." They will be transmitted post free.

NOXIOUS WEED CONTROL QUESTIONNAIRE.

1. Province.
2. District and name of property.
3. Area: Total acres
   Under pasture
   Arable.
   Hill.
   Swamp
4. Crops grown.
5. Degree of infestation of noxious weeds. Give common names, and state whether dense, sparse, or negligible; type of land and nature of soils on which the weeds grow.
6. What method(s) do you adopt for
   (*a*) clearing and cultivating land for periodical cropping?
   (*b*) clearing and cultivating for the establishment of pasture?
7. What is the cost per acre of the initial clearing of noxious weeds on your land? (Give names of weeds.)
8. How do you keep noxious weeds in check on?
   (*a*) Arable land.
   (*b*) Pasture.
   (*c*) Unused areas.
9. What is the annual cost per acre incurred by controlling noxious weeds under heads 8 (*a*), (*b*) and (*c*)?
10. Are noxious weeds increasing or diminishing on your land and in your district?
    Mention names of weeds.
11. Have you observed any factors which encourage or discourage the spread of weeds? If so, please describe them.
12. Please state any methods based on experience or observation which in your opinion are suited to the control and eradication of particular noxious weeds?

Signed:

Date: 1930.

"ADCO" MANURE.

A Paper read by Mr. AUTON, at the General Meeting of the Agricultural Society of Trinidad and Tobago, 10th February, 1927.

THE soil is the essential medium for the production of crops and although some soils are naturally rich in potential resources there are few which can be cropped economically without the addition of manure. Hence a study of the material which must be added to the soil to increase or maintain its fertility is of the greatest importance to the cultivator.

From time immemorial the standard method of enriching the soil in all the countries has been by the use of stable manure or farmyard manure. With the extensive displacement of the animal by mechanical transport the supply of this type of manure has gradually diminished and growers are faced with the problem of finding a suitable substitute. In looking round for such a substitute it may be well to consider a moment what farmyard manure really is. It is, of course, the waste solid or liquid products of animals, mixed in most cases with a certain amount of litter used for bedding. Incidentally it may be stated that the litter is valuable for absorbing the liquid excreta, as without this the most valuable part of the waste pro-

ducts is frequently washed out and lost. The raw material from which these waste products are directly or indirectly derived is invariably vegetable matter, a cellulosic substance. The processes of digestion and assimilation of food in the animal system are promoted by ferments called enzymes and obviously if we can cause vegetable matter to undergo similar processes independent of the animal we are in a fair way to provide a substitute for farmyard manure. Not only so but the substitute will be better than the original.

In the case of the animal much of the most valuable constituents have been extracted to provide for the growth and energy of the animal. In the case of the substitute, however, the whole of the constituents will be present and, if the process is successful, in a readily assimilable form. Hence our aim must be to promote the decay of vegetable matter in such a manner that a product similar to farmyard manure is produced, but with all the most valuable constituents retained.

The value of plant tissue as a means of enriching soils with organic matter has long been recognised as shown by the fact that all up-to-date growers use every favourable opportunity of sowing catch-crops of a quick-growing nature and turning them in before the sowing of the next crop. This system of green manuring has been highly developed in certain districts and has resulted in the conversion of large tracts of sandy, barren soil into fertile areas. If it is worth while to grow crops to turn in for green manuring, it is surely worth while to conserve and turn into manure the large amount of waste vegetable matter which is available in such abundance on all plantations and estates.

Although it is known that the chief mineral and nitrogen requirements of a crop can be easily supplied by the application of chemical manures, experience shows that a plentiful supply of organic matter is indispensable for maintaining the fertility of soils. There is little doubt that the superiority of dung is due not so much to the mineral substance and nitrogen that it contains as to the organic, humus-forming material which forms its bulk. Plant nutrition is a much more complex matter than the mere provision or maintenance of the necessary elements, and it would appear that the chemical or bio-chemical changes which take place in the soil before food of plants is made available for absorption by the roots is largely dependent on its humus content.

Of the exact nature of humus little is known, and the term may be considered one of convenience rather than explanation. It is the black substance usually associated with a rich soil, and results from the decomposition of organic matter. Its influence as a fertiliser is mainly indirect, and may be considered conveniently under three headings, namely, physical, chemical and as a medium for soil bacteria.

As a physical agent the effect of humus is to improve the drainage and tilth of the soil. This increases to an enormous degree the area suitable for root action and may be illustrated by imagining the difference between an impervious lump of clay and the same intersected in every direction by innumerable channels through which roots, air and moisture may pass. Humus also helps the soil to retain moisture. For example experiments give the following results:—

100 lb of dry sand can hold 25 lb of water.
100 lb of dry clay can hold 50 lb of water.
100 lb of dry humus can hold 190 lb of water.

Humus is a non-conductor of heat, hence it fosters that equable soil temperature so desirable for steady growth.

Chemically humus acts probably as a catalytic agent; that is, it promotes chemical re-actions without apparently taking part in them. This type of action is quite common in chemical re-actions. For example the activity of some substances is increased many times when absorbed by charcoal and there can be little doubt that the same kind of re-action occurs in the soil. Besides this all decaying organic matter contains a considerable proportion of elements of direct, nutritive value as plant food. This cannot be disregarded, though it is proportionately less than in artificial manures.

Finally there is the question of soil bacteria importance in promoting certain chemical re-actions essential to soil fertility. These bacteria feed on the decaying vegetable matter which they help to break down and render available as food for plants. They can no more live in a soil without humus than human beings could live in a desert devoid of vegetation.

Having established the importance of humus as a fertilising agent it is necessary to inquire as to the natural supply of this substance in the soils with which we have to deal. The fibrous loams and parts which are the richest in humus are relatively small areas of the world's surface and even here deterioration starts from the moment cultivation begins and this is particularly rapid in the tropics where growth and decay are phenomenal. Every tropical planter can point to fields which once were fertile but which now are poor or abandoned and the amazing difference in the yield per unit or per area in highly cultivated plantations and those where cultivation is neglected is a striking example of the necessity of maintaining fertility. The centres of high fertility are gradually moving, whatever the crop, and the extensive use of artificials during the last fifty years has not checked this. That this loss of fertility can be avoided is shown by the manuring trials carried out at the Rothamsted Experimental Station on what is now the most famous wheat field in the world which produced its 75th crop in 1925. One crop in this field has received annually farmyard manure only, during whole period; other plots have been continuously manured with standard artificials and mixtures. A critical comparison of the records of these plots now reveals the fact that the only plot which shows no deterioration whatever is that which has received farmyard manure, thus it would appear that the only way to maintain fertility is by giving liberal dressings of humus-forming manure. The water-holding capacity of humus has already been noted, hence a soil with high humus content is an insurance against drought. Even a fertile soil without water becomes a desert as witness the changes from desert to highly productive areas in Egypt, Southern California and North-West India by the introduction of water. It is safe to say that the crops of the world are more dependent on water than nutrients in the soil and whilst rainfall is beyond human control we possess in humus the power to increase the water-holding capacity of any soil.

It is largely owing to a knowledge of these facts that the "Adco" process appeals to the thoughtful grower. It has been known to the public for a very short period, yet its fame is already world-wide. The Scientific discoveries on which it is based appeared unobtrusively in the scientific Press and notes regarding the process found their way into the agricultural journals. To-day manure is being produced by the Adco process in England, France, Spain, Canada, United States, West Indies, South and West Africa, New Zealand, Malaya, Australia, India, Ceylon, Japan, Rhodesia, and Mauritius while inquiries from all parts of the world increase daily. It has needed no advertising to achieve this success. It appealed immediately to all serious agriculturists for a very simple reason, it offered no novel, artificial

understands. We call this manure synthetic farmyard manure or "Adco" manure because it is produced without the agency of animals.

Standard "Adco" is a fine powder which embodies late scientific discoveries. Its function is to create the ideal conditions which cause the useful bacteria to work and also to increase the amounts of plant nutrients in the finished manure. It is invaluable in the great grain growing districts where machinery is displacing the animal, and where large quantities of straw, maize stalks, &c., are available. It is ideal for the tropics where weeds and vegetation are plentiful and where fermentation is rapid. Dunging has never been sufficiently possible on the great plantations hitherto, but the "Adco" process now offers a simple and perfect means of accomplishing this. "Adco" manure is made by stacking and wetting any type of vegetable refuse layer by layer and mixing with it "Adco" powder until a pile about six feet high is completed. The stack should have a flat top so as to hold water, not shed it. After the stack has been built there is nothing to do but to keep it moist until it is well rotted and ready for use. The method of stacking the heaps depends to some extent on the type of material being treated and users of the process will soon gain experience as to the best methods. For the benefit of new users it may be helpful to describe more or less in detail the method of stacking a heap of material of say about five tons. It may at once be said that in the tropics a shallow trench about 2 feet deep is a decided advantage. For a heap of this weight about 7½ cwt. of standard of "Adco" would be required. Estimate roughly the division of the material into 6 lots and arrange the first lot on a square base with about 7 yards side. Water through a rose or any convenient form of sprayer and when well wetted sprinkle as evenly as possible 1 6th of the "Adco." Sprinkle with a little water just sufficient to clean the top of the layer. Spread another layer and continue the process until the whole of the material is in position and partly wetted seeing that the last layer of "Adco" is covered with a few inches of refuse and well wetted. In a few days the stack should heat to at least 80° F.; when another 1,000 gallons of water may be applied, and repeat this at intervals of about three days until the whole stack has received 4,000 gallons of water in all. The temperature will gradually rise until a maximum of 180° is reached but under certain conditions this may be as long as three or four weeks. Thorough trampling of the heap as it is built up is desirable and care should be taken that the top of the stack should be left as level as possible and not more than 6 or 8 feet high, the object being to facilitate the taking up and holding of the natural rainfall. The manure should be ready for use in from three to six months, the exact time depending on the nature of the material treated and the state of decomposition required of the finished product. A well made Adco heap can be cut out easily with an ordinary spade. It cannot be too much emphasised that the question of moisture is a controlling factor in the success of the process and uniformity of moisture throughout the heap is absolutely essential. A heap which is uniformly moist and well trampled ferments steadily with an even temperature curve, whereas a heap loosely packed with unmoistured portions is liable to violent fluctuations of temperature and besides seriously affecting the physical condition of the heap, it must not be forgotton that if the temperature rises too high valuable constituents may be lost through volatilisation.

Where large quantities of "Adco" manure are to be made the provision of water is sometimes a serious problem and it is obvious that "Adco" stacks should be made near a water supply. Every advantage should be taken of local conditions, however, to meet this problem. For example weeds, grass,

cuttings and sandy vegetable trimmings contain about 90 per cent. of water in their fresh state. If left exposed to wind and sunshine even for a short time this content is reduced to 15 per cent. and the necessity is entailed of applying the balance artificially.

Further, such fresh material is richer in nutrients than dried or withered material and it is thus of double advantage to use the fresh material.

In an exposed position the windward side of the heap will dry out quickly and check the fermentation, hence a sheltered spot is to be preferred or, as an alternative, a bank of earth can be thrown up or any other improvised protection can be arranged. In the rainy season in tropical or sub-tropical countries with from 5 to 10 inches of rainfall per month for three consecutive months no additional water is required after the stack is made.

Practically all the refuse from English agriculture and horticulture has been successfully treated and almost every waste known in tropical agriculture has been tested. Some yield better manures than others but all appear to be amenable to treatment. Some idea of the diversity of raw material will be gained from the following list of the more important examples which have proved suitable. Straw, including wheat, barley, oats, and rice; banana leaves, pineapple leaves, maize stalks, tea prunings, wild grasses, including lusenke of Uganda, goura of Brazil, sudd of the Nile, neld of Rhodesia, Lallang of Malaya and rushes of England, sugar cane trash, rice husks, water hyacinth, coffee waste, gayule, a rubber waste of Mexico, bracken, hop vines, wild sunflower, and garden refuse of every description.

The cost of making "Adco" manure is naturally a business concern of the would-be user of the process. Since local conditions overseas vary so greatly it is difficult to give reliable estimates for the cost of making in different countries and for the wide range of materials which are available. On the basis that 1 ton of dry material of a proportionately greater weight of moist material will produce 3 tons of finished product, it will take 2 tons of Standard "Adco" to produce 100 tons of well-rotted synthetic farmyard manure. The present cost on the site may be taken at £14 10s. per ton thus it would cost to-day £29, plus labour costs on the spot to produce 100 tons of manure. Apart from actual cost, however, there is the advantage in "Adco" manure that it is more bulky than pen manure and 15 tons per acre is a good dressing, and has actually given better results than 20 tons of ordinary dung. Further on large estates the heaps can be spaced at convenient distances and thus save part of the cost of transport which would be entailed in moving dung purchased from an outside source.

Mr. C. A. Jones, Agronomist of the Ste. Madeleine Sugar Co., Ltd., stated that some years ago the Local Department of Agriculture tried an experiment to break down organic matter with the use of certain chemicals but that it was not entirely successful. This experiment, however, aroused a considerable amount of interest in the subject of increased output of pen manure on our estates and brought back to memory a letter received from Dr. Tempany, Director of Agriculture, Mauritius, in 1919, which was published in the *Agricultural News* describing a method used in Mauritius for producing pen manure in large quantities.

For the last few years the Ste. Madeleine Sugar Co. have been using a modification of the Mauritius method and by this means have increased their output of pen manure per head of stock very considerably. This modified method is quite simple and can be carried out in the ordinary pens found on sugar estates. The bedding instead of being thrown in the pens in its full length is passed through a cutter and the chopped up material is

spread evenly over the surface of the pen. Cattle then trample it down and their droppings supply the material required for breaking down the bedding. The pen manure produced per head of stock is in this way increased at least four-fold. The limiting factor being the amount of bedding that is available, as on most sugar estates the head of stock is ample.

The difficulty, however, on many estates is to get the manure out to all the fields. Many fields are situated at a distance from the railway or gravelled roads and for this reason it is often impossible to cart the manure from the pens to such fields in the wet season, the result being that in the past these fields have never been pen manured, consequently their fertility has been considerably lowered.

By the use of "Adco" it was hoped that fields so situated could be pen manured and it was with this object, mainly in view, that five trial heaps were laid down during the last year on the estates of the Ste. Madeleine Sugar Co.

Mr. Auton has given an account of the method used in setting up the heaps and Prof. Hardy has given the results of the chemical analyses of the resultant manure. At Mr. Auton's request, I have attempted to collect information as to the use of the manure, and taking the Union Hall heap as a typical example the following expenditure was incurred:

Labour.—Cost of collecting trash in dry season setting, watering, turning and weighing of heaps ..	$45.00
Cost of "Adco."—6 cwt. at £14 10s. per ton ..	20.88
Total cost	$65 .88

The weight of the final manure made from 6 tons of trash and 6 cwts. of "Adco" was 21·6 tons. The cost therefore works out at slightly over $3·00 per ton of manure.

The cost of making Mauritius pen manure is probably less than this and it cannot be claimed that the "Adco" process is cheap. Indeed pen manure by whatever process it is made is expensive but there is no efficient substitute for it and it is an expenditure that has to be faced. At Ste. Madeleine we make something like 30,000 tons annually and we are anxious to increase this to 50,000 tons. The money that used to be expended in the purchase of artificial manure is now being used in making more and more pen manure. We are getting convinced that "Adco" will have its place in the future routine work of our estates as one means of adding to the humus content of our soils.

Mr. T. I. Potter asked: "Will Mr. Auton kindly inform us whether the "Adco" preparation can be applied to coconut husks with the object of converting these into synthetic manure for coconut estates? I ask this question because a member, who was unable to be present to-day, and who owns a coconut plantation, is curious to know whether 'Adco' can be used for this purpose on coconut estates, where a very large quantity of husks is allowed to decay under the trees. I am also anxious to know this myself."

The Chairman remarked that he did not believe that coconut husks would respond readily to treatment with "Adco" owing to the large percentage of tannin in the fibre, which acted a a preservative or resistant, and consequently delayed decomposition.

Mr. Auton observed that he had not experimented with coconut refuse, therefore he could not readily answer the question.

Mr. Jos. de Verteuil made some observation detailing his experiments at Valsayn in prefacing which he referred to the question asked by Mr. Potter.

Department of Agriculture,
Port-of-Spain, 8th February, 1927.

SYNTHETIC PEN MANURE PREPARED AT "ENDEAVOUR" ESTATE, CHAGUANAS, BY THE "ADCO" PROCESS.

Mr. Jos. de Verteuil, Agricultural Chemist of the Department of Agriculture, said that he had analysed Synthetic Pen Manure prepared at "Endeavour" Estate, Chaguanas, by the "Adco" Process with the following results:

Dry grass, which had been cut two or three weeks previously, was used for making the heap.

Started 10th November, 1926.
Completed 16th November, 1926.
Put out in the field 1st to 4th February, 1927.
Heap 30 by 30 by 4½ feet—sunk to 19 inches.
130 lb of "Adco" was spread over each layer, one foot thick, and last layer covered with 3 to 4 inches dry grass.

The first layer was properly trampled and thoroughly wetted, but no further watering was necessary as there were good rains whilst the heap was being built up.

Cost.

Cutting grass from field (about 5 acres)	$9·85
Heading out grass	2·73
Carting 70 loads dry grass (¼ to ½ mile)	3·13
Building heap	3·28
Wetting heap after being built (3 times) ..	3·20
Cost of 520 lb "Adco" at $71·34 per ton ..	16·56
	$38·75
Average weight of a load dry grass 225–250 lb ..	7 to 8 tons.
61 loads manure obtained (7 loads weighed on an average 800 lb each)	21 tons.
Cost of manure per ton	$1·85

Analytical Results.

	Natural sample.	Dried at 100°C.
Water	77·38	----
*Organic and volatile matter .	15·76	69·67
†Mineral matter	6·86	30·33
	100·00	100·00
Containing	Per cent.	Per cent.
*Nitrogen	0·51	2·25
†Lime (CaO)	1·10	4·86
†Potassium oxide K^2O ..	0·26	1·15
†Phosphoric anhydrido P^2O^5	0·81	2·69

Professor F. Hardy, of the Imperial College of Tropical Agriculture, said that he had tested a sample of Synthetic Pen Manure, which was prepared at the St. Augustine Experiment Station, from Dry Cane Trash and he obtained the following results:—

Thirty-three tons of trash were weighed and treated with 2 tons of the "Adco" reagent.

The analytical results compared with air-dried cane trash and pen manure, also prepared at the Experimental Station, are as follows:—

	"Adco" Manure. Per cent.	Pen Manure. Per cent.	Cane trash. Per cent.
Moisture	74·03	71·65	15·42
Organic matter	17·38	16·86	75·57
Ash	9·20	12·50	9·01
Nitrogen	0·57	0·58	0·95
Nitrogen calculated on dry material ..	2·14	1·97	0·98

Proceedings of the Agricultural Society of Trinidad and Tobago, Vol. XXVII Part 2.

FIJI LIVESTOCK RECORD ASSOCIATION.

MINUTES OF MEETING OF BOARD OF DIRECTORS HELD ON THE 10TH APRIL, 1930.

Present: Senior Veterinary Officer; Messrs. Kiss, Barber and Craig. The Senior Veterinary Officer presided in the absence of the Superintendent of Agriculture.

1. The minutes of the previous meeting of the Board were read and confirmed.

2. Accounts, as under, were passed for payment:

Leighton Ltd.—Rubber Stamps	£0	9	9
Government Printer—Rules	1	7	6

3. The Chairman pointed out that under the Rules of the Association animals registered on account of each owner were required to be numbered consecutively either by fire-brand or by tattoo. He stated that many owners did not possess the facilities for the numbering of animals and suggested that the Association purchase either a set of brand numbers or a tattooing instrument. After discussion the Board directed that a tattooing instrument be purchased from the Association's funds.

4. The Chairman stated that a number of applications for registration had been received and that the animals would be inspected as soon as possible and the Herd Book opened.

COPRA PRICES.

LETTER TO DIRECTOR, IMPERIAL INSTITUTE, LONDON.

Sir, 31st December, 1929.

I have the honour to request that you would be good enough to forward to me, periodically, records of comparative prices of the different grades of copra marketed in London and Hull, and if possible, those ruling in Hamburg, Rotterdam, Marseilles and Genoa.

2. The copra industry of Fiji is feeling the depression of prices somewhat keenly. I feel that very much lies in the direction of better organisation of the industry somewhat on the lines of the rationalisation methods talked of, and doubtless practiced in Europe during the recent two years or so.

3. The quality of South Sea copra leaves much to be desired, and the matter of suggesting certain improvements directed to the production of a better grade of copra is receiving my attention. I shall be grateful at a

later date for the co-operation of the Imperial Institute on the lines afforded Zanzibar during the tenure of my office there. The copy of the report on the four samples of Zanzibar copra examined at the Institute, and submitted to Brokers for their information, handed to me by Mr. Brown, has been of considerable use to me personally, and no doubt was welcomed by the Department in Zanzibar, as it gives more definite information regarding the relative prices of the grades of copra submitted than was hitherto available.

4. I shall be grateful for the expression of an opinion as to the main reasons for the continued fall in the market value of copra; whether prices have reached a stable level or whether they are likely to continue to fluctuate considerably in the near future. My own view is that the recent amalgamations of the largest consuming companies have cut down competition for vegetable oils to a great extent and thus contributed to a reduction in the market price of copra, as well as of other oil-bearing materials.

5. I realise that this is only one factor, but it nevertheless seems to me to be an important one, and it is necessary for the business of production to be so organised as to keep down production and marketing costs.

6. You might care to invoke the assistance of the Empire Marketing Board in this matter, which is of great importance to the Colony of Fiji.

I have, &c.,
A. C. BARNES,
Superintendent of Agriculture.

REPLY FROM DIRECTOR, IMPERIAL INSTITUTE, LONDON.

Imperial Institute,
London, S.W.7.
17th April, 1930.

Sir,

With reference to your letter No. 1405/29 of the 31st December last on the subject of copra prices, I shall be glad to send you periodically a list of the comparative prices of the different grades of copra marketed in Europe.

A table is enclosed, taken from the Copra Market Report issued by Messrs. L. M. Fischel & Co., giving the c.i.f. quotations for different grades of copra at the principal European ports on the 15th January, 19th February and 5th March, 1930. The London, Rotterdam and Hamburg c.i.f. quotations are identical, but the Marseilles values differ slightly and are given separately.

A copy of Messrs. Fischel & Co.'s report dated the 26th March is also enclosed. This includes notes on the market position, the c.i.f. quotations referred to above, and the principal daily spot prices fixed by the London Copra Association.

You do not indicate how frequently you would like to have such reports but it is proposed to send you a copy of Messrs. Fischel's report at the end of each month. I shall be glad to learn whether the information given in the report and the proposed interval of despatch will meet your requirements.

The Imperial Institute will be glad to assist in any possible way to promote the improvement of the copra produced in Fiji and to furnish reports, on the lines of that previously supplied to Zanzibar, on any samples which you may forward for examination.

With reference to your inquiry regarding the market value of copra, it is generally held in the trade that the following factors have contributed to the fall in price.

A large increase in the shipments of copra from the principal producing countries (exclusive of the South Seas and African supplies) occurred in 1928, during which year the total shipments from these sources were 30 per cent. (*i.e.*, about 200,000 tons) higher than the average for the three preceding years. The figures for 1929 indicate that this increase has been maintained.

During the same period there was also a considerable increase in the shipments of a number of other important oils and oilseeds including whale oil, which is now being largely used in the edible oil trade. Statistics giving the shipments of copra, palm kernels, groundnuts, soya beans, olive oil and whale oil during the last three years are enclosed. This increased production has tended to depress the prices of all oils and oilseeds, and the difficulty has been accentuated recently by a marked decline in the demand for feeding cake and meal. The latter is attributed chiefly to the excellent grain crops obtained last year in most European countries as a result of which large quantities of coarse grain have become available for feeding purposes.

It is also held that well-organised buying by the principal users of copra and dependent selling by producers have helped to lower the price. In this connection it is alleged that the formation of the Margarine Union has had an important effect as it is stated that the Union has established a single buying agency, thereby eliminating competition between its constituent firms, and is able by virtue of the large scale of its market operations to influence the price of copra and other oilseeds.

At present it is difficult to make any forecast as to the future position, especially in view of the general economic situation and the fall which has occurred in almost all commodity values. The whole question is however being kept in view here and, in this connection, your suggestion that the Empire Marketing Board might be consulted will be borne in mind.

The trade reviews on the Oil and Oilseed markets during 1929 have just been issued by Messrs. Faure Blattman & Co. and Messrs. Frank Fehr & Co. and copies of their remarks on copra and coconut oil are attached for your information.

HAROLD BROWN,
for Director (Lt.-Gen. Sir William Furse).

COPRA.

NOMINAL QUOTATIONS AT EUROPEAN PORTS, c.i.f. d/w, USUAL TERMS.

	15th January, 1930 January/February shipment.				19th February, 1930 February/March shipment.				5th March, 1930 March/April shipment.			
	Ports.*		Marseilles.		Ports.*		Marseilles.		Ports.*		Marseilles.	
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.	
Malabar .. G.W.S.	24 7 6		24 7 6		23 12 6		23 12 6		22 15 0		22 15 0	
Ceylon .. F.M.S.	24 2 6		24 2 6		23 7 6		23 7 6		22 7 6		22 7 6	
Singapore .. F.M.S.	22 15 0		22 15 0		22 7 6		22 7 6		21 5 0		21 5 0	
Straits .. F.M.	22 0 0		22 0 0		21 10 0		21 7 6		20 7 6		20 5 0	
East Africa .. F.M.S.	21 15 0		21 15 0		21 10 0		21 7 6		20 7 6		20 5 0	
Manila .. F.M.	21 10 0		21 10 0		21 0 0		21 0 0		19 12 6		19 12 6	
Cebu .. .. F.M.S.	21 17 6		21 12 6		21 10 0		21 5 0		20 2 6		20 2 6	
Macassar, &c. F.M.	21 10 0		21 10 0		21 0 0		21 0 0		20 0 0		19 17 6	
Plantation Rabaul South Sea	21 17 6		21 12 6		21 12 6		21 7 6		20 7 6		19 17 6	
South Sea .. F.M.S.	21 15 0		21 10 0		21 10 0		21 5 0		20 5 0		19 15 0	

* London Rotterdam, Hamburg.

COPRA MARKET REPORT—26TH MARCH, 1930.

L. M. FISCHEL & CO., LTD., 36 AND 37, MINCING LANE, LONDON, E.C. 3.

We have to report an irregular market during the past week. At the opening a firm tone prevailed owing to a good demand from dealers for speculative grades, together with a better inquiry from consumers, and prices advanced 7/6 to 12/6 per ton. At the higher levels, however, buyers became more reserved and part of this improvement was soon lost, since when business has taken place at prices which have fluctuated within narrow limits, shippers generally have refrained from offering to any extent and at the close the tone is quiet but steady with quotations unchanged to 10/- higher than last week.

The Marseilles market opened firm and up to £20 10s. was reported paid for Kiln-dried South Sea Afloat, and £20 7s. 6d. for March/April shipment, with other grades on a parity. Following this, prices gave way about 5/- per ton and at the lower level a fair business is reported in most grades, with afloat parcels commanding a premium of 2/6 to 5/- per ton, according to the steamer's position. At the close nearest values may be given as £20 2s. 6d. for Kiln-dried South Sea, and £20 5s. for Mixed Dutch East Indies, March/April shipment.

There has been a moderate inquiry from Northern European ports although the business reported is small.

Nominal Quotations for April Shipment c.i.f. d/w Usual Terms.

		1930.		1929.	
		c.i.f. usual Ports.	c.i.f. Marseilles.	c.i.f. usual Ports.	c.i.f. Marseilles.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.
Malabar	G.W.S.	23 0 0	23 0 0	24 10 0	24 10 0
Ceylon	F.M.S.	22 12 6	22 12 6	24 5 0	24 5 0
Singapore	F.M.S.	21 10 0	21 10 0	23 7 6	23 7 6
Straits	F.M.	20 10 0	20 10 0	22 15 0	22 10 0
East African	F.M.S.	20 7 6	20 10 0	22 10 0	22 10 0
Manila	F.M.	20 0 0	20 0 0	22 7 6	22 7 6
Cebu	F.M.S.	20 10 0	20 7 6	22 15 0	22 10 0
Macassar, &c.	F.M.	20 5 0	20 5 0	22 5 0	22 5 0
Plantation Rabaul South Sea		20 12 6	20 10 0	22 15 0	22 10 0
South Sea	F.M.S.	20 12 6	20 7 6	22 12 6	22 7 6

Principal Daily Spot Prices fixed by the London Copra Association, 21st March:—

London—basis bags—F.M.S. Ceylon, £22 7s. 6d.; West Indian, £21 12s. 6d.; F.M.S. Java, £21 10s.; F.M.S. Dutch East Indies, £21 7s. 6d.; Mixed Dutch East Indies, £20 7s. 6d.; F.M.S. Straits, £21 7s. 6d.; F.M. Straits, £20 10s.; F.M.S. Mozambique, £20 15s.; F.M.S. Philippine, £20 12s. 6d.; F.M. Philippine, £20 5s.; H.A.D. Plantation Rabaul, £20 17s. 6d.; F.M.S. Plantation Rabaul, £20 17s. 6d.; Plantation South Sea, £20 15s.; F.M.S. Samoa, £20 15s.; F.M.S. South Sea, £20 12s. 6d.

Liverpool, Antwerp, Germany, Holland same as London; Hull, 5/- extra.

STATISTICS OF THE TOTAL SHIPMENTS OF SOME OF THE PRINCIPAL OILSEEDS AND OF THE WORLD'S PRODUCTION OF OLIVE AND WHALE OIL, DURING 1927, 1928 AND 1929.

COPRA AND COCONUT OIL.

	1927	1928	1929	
Copra.	*tons.*	*tons.*	*tons.*	
Total shipments from the principal producing countries (exclusive of South Seas and African supplies).	676,481 .. 680,341	866,317 .. 875,224	900,908 .. 859,580	Review of the Oil and Fat Markets, 1929, by Faure Blattman & Co. Particulars of shipments of Copra by L. M. Fischel & Co.
Coconut Oil.				
Exports from principal producing countries.	199,000 ..	221,000 ..	(*a*)	Official figures.

(*a*) The official figures so far available indicate that the total in 1929 should not be less than in 1928.

PALM KERNELS.

Palm Kernals.	1928 *tons.*		1929 *tons.*	
Total imports into principal European countries.	491,964	....	479,856	Faure Blattman & Co.

GROUNDNUTS.

Shipments from	1927 *tons.*		1928 *tons.*		1929 *tons.*	
India—						
Groundnuts	474,882	..	748,603	..	816,379	Official figures.
Groundnut oil (gallons)	55,886	..	352,341	..	269,867	Do.
China—						
Unshelled	54,379	..	55,522	..	*	Do.
Shelled	91,724	..	46,261	..	*	Do.
Senegal	399,202	..	406,986	..	380,313†	Do.
Gambia	65,107	..	74,442	..	49,751‡	Do.
Nigeria	90,773	..	103,161	..	94,330‡	Do.

* Information not yet available. † January–December 15th. ‡ January–September.

The official figures for the total production of unshelled groundnuts in India are 2,046,000 tons in 1926–27 and 2,657,000 tons in 1927–28.

The following figures of the total imports of groundnuts into the principal consuming countries are given by Messrs. Faure Blattman & Co.

1927 *tons.*		1928 *tons.*		1929 *tons.*
1,249,378	..	1,605,926	..	1,747,834

SOYA BEANS AND OIL.

Shipments from	1926–27* *tons.*	1927–28* *tons.*	1928–29* *tons.*	1929† *tons.*	
Manchuria—					
Soya beans	1,621,697 ..	2,040,982 ..	2,897,200 ..	573,400	Faure Blattman & Co.
Soya oil ..	167,098 ..	89,235 ..	98,718 ..	21,457	Do.

* 1st November to 31st October. † November and December.

OLIVE OIL.

	1927 *tons.*		1928 *tons.*		1929 *tons.*	
World's production ..	965,000	..	718,000	..	1,007,000	Review of the Oilseed, Oil and Oil Cake Market by Frank Fehr & Co.
World's production ..	1,079,021	..	627,648	..	1,003,347	Faure Blattman & Co.

WHALE OIL.

	1927 *barrels.*		1928 *barrels.*		1929 *barrels.*	
World's production ..	1,220,415	..	1,356,308	..	1,861,877	Frank Fehr & Co.
	tons.		*tons.*		*tons.*	
Converted at rate of 6 barrels.	203,400	..	226,050	..	310,313	

EXTRACT FROM "REVIEW OF THE OIL AND FAT MARKETS, 1929."

(Published by Messrs. Faure Blattman & Co.).

COPRA AND COCONUT OIL.

Our forecast that 1929 would be a year of large copra supplies, and that the bulk of the surplus over previous years would be taken care of by the U.S.A. has proved correct. The total shipments for the year amounted to 960,908 tons against 866,317 tons last year, and the total copra imports into the U.S.A. for the year amounted to 253,543 tons against 221,172 tons in 1928. The total imports into the principal consuming countries were 1,115,909 tons during 1929 against 974,946 tons in the previous year. Generally speaking, the copra shipments were heavy during the first half of the year, but showed a considerable falling off towards the latter part, the most noticeable drop being in the exports from the Philippines.

The imports of copra and coconut oil into the U.S.A. for 1929 show a considerable increase over the previous year, the total quantity of copra calculated as oil and coconut oil combined imported during 1929 amounted to 349,060 tons in 1929 against 273,536 tons in 1928. Undoubtedly the U.S.A. imported in excess of their requirements in anticipation of a tariff being imposed which is borne out by the increase in stocks, which, for copra as oil and coconut oil combined, amounted to 99,307 tons on the 31st December, 1929, against 65,034 tons on the 31st December,

1928. The excess quantity was mainly bought at the beginning of the year when America sent over large orders for Straits copra. Early in the Summer, America ceased to compete for supplies of Straits copra, but entered the market again in December, when further heavy purchases were made.

The Philippine copra shipments show a considerable falling-off being only 167,145 tons against 218,921 tons in 1928, but this is largely accounted for by an increased quantity of Philippine copra being shipped to the U.S.A. in the form of coconut oil. The shipments of coconut oil from the Philippines to the U.S.A. amounted to 186,816 tons in 1929, against 136,344 tons in 1928.

On the whole, the tendency of the market has been downward, the lowest price being reached in June, when sun-dried Straits and sun-dried D.E.I. was actually sold at £20 5s. nett. When the market had reached this level, however, the U.S.A. once again bought heavily, with the result that a sharp reaction set in, until £23 12s. 6d. was reached in September. The market then became sluggish and with small fluctuations gradually receded to £22 10s., which was the value at the end of the year.

During the first half of the year copra was cheap when compared to other oilseeds but during the second half of the year the position was reversed, and copra was not affected by the general drop which took place.

The reports from the Dutch East Indies, the Philippines, Straits and Ceylon, all seem to indicate the probability of small supplies during the next few months, but there is no reason why there should not be an improvement later in the year.

There seems to be again a tendency to increase the production of coconut oil in the copra-growing countries, as is shown by the increase in the shipments from the Philippines, also from the D.E.I. and from Ceylon.

EXTRACT FROM "REVIEW OF THE OILSEED, OIL AND OIL CAKE MARKETS FOR 1929."

(Published by Messrs. Frank Fehr & Co.).

COPRA.

Production of copra has again increased during the year under review.

Total shipments, including those of "Other Dutch East Indies," were 918,340 tons for 1929, compared with 905,398 tons in 1928.

Shipments to the United Kingdom rose to 90,299 tons, compared with 61,901 tons for 1928.

German imports were also larger at 240,696 tons for 1929, against 197,597 tons in 1928.

French imports, which were 180,960 tons in 1928, also show an improvement, being 188,370 tons for 1929.

Holland also shows a slightly higher figure at 140,272 tons, against 137,078 tons.

Imports into the U.S.A. during 1929 stood at 254,880 tons, compared with 223,652 tons for the previous year. In connection with this it is also interesting to note that apart from larger imports of copra, the quantity of coconut oil taken by the U.S.A. during 1929 was 183,900 tons, compared with 129,750 tons in 1928.

Examining the export figures, we observe a decline in the shipments of Manila copra, being 178,018 tons for 1929, against 201,000 tons for 1928. This difference, however, is well replaced by the larger shipments of coconut oil.

On the other hand shipments from the Dutch East Indies were more liberal, being 452,757 tons, compared with 436,493 tons for 1928.

The same refers to exports from the Straits Settlements, which rose to 186,112 tons, against 173,555 tons; while Ceylon shipments were also higher at 101,453 tons, against 94,250 tons.

There was a slight increase in the shipments of Ceylon and Java coconut oil during 1929. Ceylon exported 41,523 tons compared with 36,056 tons for the previous year, and Java 34,433 tons, against 33,537 tons.

The average price of F.M.S. Singapore copra c.i.f. London, during 1929 was £23 1s. 3d., compared with £26 7s. 6d. for 1928 and £27 7s. 6d. in 1927. The average price for 1929 was the lowest for recent years.

We started the year at £24 7s. 6d. in January, which price with minor fluctuations was maintained during February. In March we fell to £23 5s. and by June we were down to £21. In July prices improved to £23 6s. 3d. This higher level of prices was maintained during August and September, the average during the latter month being £24 1s. 3d. As shipments became more liberal and demand for cake decreased, the copra market followed the decline in the markets of other oilseeds and at the end of the year we saw the price down again to £22 12s. 6d.

It will be observed, however, that the decline in the price of copra since the turn of the year has been in no way as drastic as that of other oilseeds. The lowest price we have seen for copra was £20 17s. 6d. on the 7th March, 1930. During the same period the price of palm kernels fell to £14 5s. for afloat parcels, and that of Coromandel groundnuts to £15. The explanation of this can be found in the fact that at a low level of prices for cakes, the crushers naturally give preference to oilseeds containing the highest percentage of oil, or to copra "par excellence."

COCONUT OIL.

Manila.—During 1927 and 1928 the market for Manila coconut oil in America fluctuated between 8¼ and 8¾ cents per lb, c.i.f. New York, but in 1929 there was a wider movement. In January the average price in New York was 8¼ cents per lb. In August it fell to 6¾ cents, and closed in December at 7 cents per lb. It is interesting to observe the large increase in the imports of Manila coconut oil into the U.S.A., which rose from 129,750 tons for 1928 to the enormous figure of 183,900 tons during 1929.

Ceylon.—There is a further increase in the shipments of Ceylon coconut oil, which were 41,523 tons during 1929, against 36,056 tons in 1928 and 30,255 tons for 1927. In our last report we mentioned the gradual decline in prices of £4 to £5 per ton. A similar decline took place during 1929, so that compared with values ruling during 1927, the price of Ceylon coconut oil shows a fall of, approximately, £10 per ton. The United Kingdom and Italy were again the principal buyers of this commodity.

Java.—Shipments from Java show a small increase, being 34,433 tons in 1929, compared with 33,575 tons in 1928.

CONTENTS.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 3.] THIRD QUARTER, 1930. [No. 3.

EDITORIAL.

NOXIOUS WEEDS.

IN this issue will be found the first part of an article on the subject of Noxious Weeds and their Control in Fiji, which summarises the replies to the Questionnaire issued by the Department of Agriculture in March of this year. This subject will be discussed at the Agricultural Convention to be held in Suva at the time of the Fiji Show in October and a further article will be published in a later issue of the *Journal*.

Approval has been given for investigations to be conducted in Trinidad on the insects found by Mr. Simmonds to exercise some control on *Clidemia hirta* in that Island. Readers will remember he called attention to insect agencies other than Thrips which were found by him to attack the seeds and thus check the spread of the plant.

Attention has been called to the increased occurrence of a weed locally known as "Wild Verbena," "Purple Top" or "Purple Weed" (*Verbena bonariensis*) on land in the Wainimala River district. It is recommended that this weed should be pulled out and destroyed wherever it is seen.

Experimental work with sodium chlorate as a spray is being continued at Nasinu. As far as can be ascertained at present *Clidemia hirta* is affected to a greater extent than most of the other weeds, but whether or not it is killed completely remains to be seen. The spray appears to exercise a selective action on the different weeds, some of which are affected much more seriously than others. Lantana, curiously enough, appears to recover completely from the effects after a time, as also does Blue Rat Tail.

COPRA DRIERS.

The Coconut Committee has authorised expenditure on the erection of an inclined chamber copra drier to deal with native copra in a district easily accessible from Suva and plans and specifications are now in course of preparation. Several types of copra driers are in operation in Fiji and these will be made the subject of an investigation in the near future, with the object of evolving a standard type. The design approved for the one to be erected by the Coconut Committee appears to be the best of those hitherto investigated. The drier will be erected in such a manner that minor modifications can be easily effected.

RHINOCEROS BEETLE.

This serious pest of coconuts is increasing rapidly in Western Samoa, owing mainly to the breakdown in the beetle control formerly exercised in that territory. The danger of introducing the beetle to Fiji is thus increased and the matter of instituting more effective preventive measures is under consideration.

NOXIOUS WEEDS AND THEIR CONTROL IN FIJI.

By A. C. Barnes, Director of Agriculture.

PART I.

In March, 1930, a Circular Letter and *Questionnaire was issued by the Department of Agriculture calling for information regarding noxious weeds in the different provinces of the Colony. Thirty-seven replies were received from the following provinces:—Ba, Bua, Cakaudrove, Kadavu, Lomaiviti, Lautoka, Lau, Macuata, Naitasiri, Nadroga, Nadi, Rewa, Ra and Tailevu. On the whole the response has been good and it is now possible to summarise the position in regard to this serious aspect of local agriculture.

Attention should be called in the first instance to the fact that plants of economic value in certain provinces and for certain agricultural pursuits are regarded as noxious in others. Thus, for example, one may mention Johnson Grass (*Sorghum halepense*, Pers.); Guinea Grass (*Panicum maximum*, Jacq.); Sensitive Grass (*Mimosa pudica*) and Para Grass (*Brachiaria mutica*, Stapf.) are welcomed on pasture land, but are a nuisance in cultivated areas, particularly in the cane districts.

It is difficult from the information at present available to decide in what order of importance the plants regarded as noxious weeds should be set out, for the reason already given and for other reasons dependent on the nature of the soil, climate, rainfall and agricultural pursuits followed in the various provinces.

The following list of plants regarded as noxious weeds has been compiled from the replies received:—

Johnson Grass	*Sorghum halepense*, Pers.
Nut Grass	*Cyperus rotundus*, L.
Guinea Grass	*Panicum maximum*, Jacq.
Prickly Solanum ..	*Solanum torvum*, Sw.
Guava	*Psidium Guavava*, L.
Ellington Curse . ..	*Acacia farnesiana*.
Vaivai	*Leucaena glauca*, Benth.
Monkey Pod	*Pithecolobium dulce*, Benth.
Noogoora Burr . ..	*Xanthium chinense*, Mill.
Fern	
Koster's Curse	*Clidemia hirta*.
Lantana	*Lantana camara*, L.
Blue Rat Tail	*Stachytarpeta indica*.
Thurston Grass.. ..	
Burr (unnamed) ..	
Sensitive Grass . ..	*Mimosa pudica*.
Para Grass	*Brachiaria mutica*, Stapf.
Mile-a-minute	*Mikania scandens*, Willd.
Chinese Burr	*Triumfetta rhomboidea*, Jacq.
	Ipomoea coccinea, L.
	Ipomoea quamoclit, L.
	Ipomoea quinquefolia, Griseb.
Kaumoce	*Cassia tora*, L.
Burr Grass	*Cenchus echinatus*
Blue Fower (Sigatoka)..	*Eleophantis scaber*.
Seed Grass	

* *Agricultural Journal*, Vol. 3, No. 2, 1930.

It will be convenient to consider the question as it affects the different provinces from which replies have been received.

BA PROVINCE.

The only reply received was from the Manager of the Colonial Sugar Refining Company, Limited, at Rarawai, who naturally dealt with the question from the point of view of the cultivator of sugar cane. He gives the following list of weeds occurring in his district:—In Ba-Tavua district—Johnson Grass, Nut Grass, Guinea Grass, Prickly Solanum, Guava, Ellington Curse and Vaivai; on Yaqara Estate—Monkey Pod, Ellington Curse, Guava and Noogoora Burr.

He states:—

Johnson Grass has proved the worst menace in our cultivated lands; it is found in both rich and poorer soils in the Ba District, and is spread in the droppings of stock and also by cane trucks, the seed adhering to oil and grease about the axle boxes. It is kept partially in check in fallow lands by such cover crops as Black Mauritius Bean and Rice Bean, but becomes abundantly evident again after these crops are ploughed under. It adds very considerably to the cost of cultivating sugar cane, entailing hand weeding at frequent intervals during the first six months growth.

The spread of Johnson Grass into our cane areas at Tavua has been prevented by the employment, practically ever since cane growing was started there, of some men whose sole duty is to search for, and eradicate, the grass along the tramlines and in other likely places throughout those areas. This has meant a constant expenditure, but has, without doubt, obviated a general increase in cultivation costs, entailing far greater expense throughout the Tavua District.

Under our conditions of farming, relief from the expense involved in combating Johnson Grass can scarcely be expected unless some method of biological control can be devised.

Nut Grass, although not as serious a pest as Johnson Grass, grows densely in many of our rich river flat areas. Unless kept in check, it seriously effects the "striking" and early growth of sugar cane. In very heavily infested fields, hand weeding at short intervals is necessary until the cane is about two months old. Nut Grass is infested in Fiji by a coccid which is to be found on the shoots at the ground level, and this insect, no doubt, exerts a partial control on its spread.

Guinea Grass is easier to deal with than Johnson Grass, but its eradication can entail heavy expenditure if it is not kept under control. It is spread largely by stock and in the oil and grease on cane truck axle boxes. Eradication must be carried out by digging out and destroying the stools.

Prickly Solanum is assuming menacing proportions in some of our areas along the Ba River. It appears to be spread by the agency of "bulbuls"; it is dealt with by uprooting.

Guava is a pest in land, chiefly on hill slopes, not under cultivation. We are gradually taking some of this land, where practicable, into cultivation by uprooting the Guava prior to ploughing. This is an expensive operation and is best carried out with the aid of tractors.

Ellington Curse is found on land not under cultivation. It appears to be increasingly evident in Ba-Tavua areas, and is dealt with by uprooting.

Vaivai is somewhat troublesome on rich river flats. It encroaches rapidly on the cultivated land and has to be eradicated.

Yagara Estate.—On this estate, Monkey Pod, Ellington Curse, Guava and Noogoora Burr are all dealt with by uprooting, and where practicable, burning. The area under these pests is being materailly reduced each year.

We trust this information will be of assistance to you. It will be observed that two grasses are mentioned which in pasture country would be of value, but in cane country can be a serious nuisance.

BUA PROVINCE.

Four replies were received. The principal crop is coconuts. Noxious weeds mentioned are Koster's Curse, Lantana, Blue Rat Tail, Guava, Fern, and Solanum. Methods adopted are—

(*a*) general clearing;

(*b*) uprooting of individual plants and burning.

In virgin areas it is said that practically no noxious weeds are found. The cost of clearing for cultivation is estimated at from 10s. to £3 or more per acre. Weeds are kept in check on rich land by annual cutting at a cost of upward of £1 per acre. It is stated that the annual cost of main-

taining grazing areas reasonably free from weeds is £1 on good land and 10s. on poor hills. The ravages of uncontrolled animals appear to assist the spread of weeds. One writer states that a reduction in the number of birds would tend to check the spread of weeds. The methods adopted for keeping land free from noxious weeds are clearing and planting with cover crops, such as Rice Bean and Mauritius Bean. One suggestion is that a Local Noxious Weed Board should be formed of landholders with the District Commissioner as Chairman to initiate and carry on campaigns in the different districts for the eradication and control of weeds.

CAKAUDROVE PROVINCE.

Four replies were received. Weeds found are Koster's Curse, Guava, Lantana, Blue Rat Tail, Thurston Grass. The principal industry is coconuts. Weeds not harmful to coconuts, but which interfere with efficient working of plantations are said to be Lantana, Blue Flower, Kaumoce and Sensitive Grass. One writer states that he successfully got rid of Guava on his property by removing all stock, cutting down the trees two feet from the ground and allowing Mile-a-minute to grow over the stumps. The result of this is that there is no Guava whatsoever on the area dealt with. The same writer states that Koster's Curse and Lantana can be dealt with in the same manner in that area. Lantana is said to grow rapidly and thickly on the flat where the soil is good but in other parts is not troublesome. Koster's Curse appears to be increasing. An attempt is being made to smother the Koster's Curse by planting Rice Bean. Lantana and Koster's Curse grow densely on native lands in the vicinity of European-owned estates and render it much more difficult to maintain effective control. Birds are regarded as the main factors which cause the spread of these two weeds. It is interesting to note that another plantation manager states that systematic weeding, grazing of cattle and periodic cutting of Koster's Curse and pulling out Lantana at a cost of 4s. 6d. per acre per annum is effective. Again birds are regarded as the worst offenders in assisting the spread of Koster's Curse and Lantana. Large areas of unoccupied land maintain a constant source of seeds for the reinfestation of clean areas. Still another planter removes harmful weeds by hand at a cost of 38·4d. per acre per annum.

KADAVU PROVINCE.

One reply was received indicating that the area in question is free from troublesome weeds.

LOMAIVITI PROVINCE.

Four replies were received, three from Ovalau and one from Gau. A reply from the Cawaci Mission states that crops grown are yams, taro, bananas, tapioca, sweet potatoes and European vegetables. Weeds appear not to be troublesome. Guava is kept down by regular weeding and Lantana, Mile-a-minute, Blue Rat Tail and a little Koster's Curse encountered are pulled up whenever found. A kind of Burr (unnamed) appears to give a little trouble. Paddocks are kept in order by regular weeding and burning, followed by planting of grass. The work is done by school boys. Apart from the Burr the weeds are not increasing. Cattle are said to contribute very much to the spread of Guava, which is kept under control by cutting down to ground level twice a year. The Burr appears to be a serious pest. It grows fast and the seeds stick to anything which touches them so that it is easily and rapidly spread. Blue Rat Rail is best dealt with by complete uprooting. Mere cutting simply acts as a form of pruning and the plant grows again with increased vigour.

A further reply from Cawatara, Ovalau, is in similar terms to the one dealing with Cawaci.

In cultivated land on the West Coast of Ovalau, Koster's Curse, and Solanum are regarded as serious pests but have been satisfactorily dealt with by chopping down to ground level and ploughing out the roots. The crops grown are maize, coconuts, pineapples, bananas and rice. Weeds are kept in check by periodic weeding and ploughing. The cost per acre of initial clearing is said to be £3.

Gau.—Referring to a coconut plantation the writer reports Guava and Koster's Curse to a small extent, with Blue Rat Tail. All are kept under control by clearing. Cattle are employed to keep the growth under nuts in check. The annual cost of weed control is said to be about 10s. per acre. Guava appears to be slowly increasing though Koster's Curse is kept in check but is likely to increase in the future owing to the heavy infestation of native areas. Kaumoce is said to be a nuisance.

LAUTOKA PROVINCE.

One reply was received, from the Manager of the Colonial Sugar Refining Company Limited, in the form of a general statement as below:—

The most prominent noxious weeds in the canefields and the degree of infestation are described in the following notes of our Mr. Greenwood.

These weeds are dealt with to some extent by the hoe, or in the case of Para Grass by a digging fork and to a greater extent by the use of weed destroying implements, either tractor or horse drawn. In the case of Para Grass on fallow lands, harrowing down and burning followed by one or more shallow ploughings has met with success frequently.

Their growth on fallow lands is checked by bare following with occasional stirring of the soil by implements and by the practice of planting a leguminous green manure crop.

Our unused areas being mostly barren hills do not generally afford a breeding ground for noxious weeds.

Guava has occasionally been troublesome and on land which it it intended to cultivate, cutting down, burning off and ploughing out the roots has been found the most useful way of dealing with it.

NOTES BY WILLIAM GREENWOOD, H.D.A., F.E.S., F.L.S.

Excluding the grasses, some of which are useful for fodder, and the legumes, most of which are beneficial to the soil, there are, in the Lautoka, Nadi and Sigatoka cane areas, about 60 weeds. The majority of these are of no great importance at present and do not occur in large numbers but the cane fields would be better without them. A list of the more important of these weeds with short notes is given below:—

Panicum maximum, Jacq. (Guinea Grass).—This excellent fodder grass occurs in all the three districts under consideration and in the cane fields must be regarded as a weed.

Brachiaria mutica, Stapf. (Para Grass).—Another excellent fodder grass which is a great pest in most low lying cane fields. It is common in all three districts.

Sorghum halepense, Pers. (Johnson Grass).—A bad weed in cane land but only occasionally seen in the Lautoka, Nadi or Sigatoka Districts and at once dug out by the roots and burnt.

Mikania scandens, Willd. (Mile-a-minute).—This climber, although eaten by cattle and recommended as a cover crop to keep down weeds in other parts of the world, is a very bad weed pulling the cane down in our cane fields, more particularly in the Sigatoka District.

Lantana camara, L.—A small patch of this weed was found in cane fields at Lautoka a few years ago and was destroyed. A few scattered seedlings from this patch were found later and were also destroyed and during the last two years no more has been seen.

Triumfetta rhomboidea, Jacq. (Chinese Burr).—This hard woody plant is a common weed in all cane areas.

Psidium guayava, L. (Guava).—Although not a weed in the actual cane fields, this common shrub soon appears in fields which are out of cultivation for a couple of years and on account of having to be grubbed out, much increases the cost of bringing these fields under cultivation again.

Xanthium chinense, Mill. (Noogoora Burr).—This very bad Australian weed was found in the Lautoka District about ten years ago and was destroyed. Various plants were found in the following years over a small area and were dug up and burnt. It has not been noticed during the last two or three years.

Solanum torvum, Sw.—This plant, which was common in parts of Fiji in 1906, is a bad weed on most river bank lands in the Lautoka, Nadi, and Sigatoka Districts, but not in the cane areas.

Ipomoea coccinea, L., *I. quamoclit*, L., and *I. quinquefolia*, Grisch. The first two of these creepers have red flowers and are common in the Lautoka and Nadi Districts. They seed profusely and smother the young cane after the manner of Mile-a-minute. The third species *I. quinquefolia* Grisch, has not been notice at Nadi or Sigatoka yet. Its effect on cane is just as bad as that of the others.

Cyperus rotundus, L. (Nut Grass). This weed in common right through the three Districts and like most *Cyperaceae*, is worst in wet soils. In Hawaii an attempt is being made to reduce it by means of insects and the experiment is being watched with interest.

No mention has been made of the various legumes found in cane fields such as Sensitive Plant, Phaseolus, Crotalaria, &c., as these plants enrich the soil in which they grow and are often sown as cover crops in other tropical countries.

LAU PROVINCE.

One reply in respect of coconut plantations on Kanacea Island was received. Weeds reported are Guava and Seed Grass. The clearing of dense Guava is effected by cutting and stacking for burning at a cost of 9s. to 12s. 6d. per acre. New growth is controlled by slashing and by allowing Kaumoce to form a heavy cover crop. The annual cost of controlling Guava is said to be 2s. to 2s. 6d. per acre. As the island is isolated and privately owned it is not troubled by the appearance of various noxious weeds met with in other parts of the Colony and those weeds that are present are decreasing. Experience has shown that care must be exercised in dealing with Guava. Initial clearing should be done from November to January thus giving the cover crop a full season's growth. It has been found that the growth of an annual cover crop such as Mile-a-minute, Sensitive Grass, or Kaumoce is more rapid than that of Guava. The cover crop is usually left until the following April and appears to stifle successfully the growth of the Guava. The average rainfall on the island is 58 inches per annum.

MACUATA PROVINCE.

One reply was received from Dreketi. The weeds reported are known in coconut plantations and on areas where no cultivation is practised. Guava is regarded as the most serious. The idle lands act as the centres for reinfestation of districts where weeds are kept under reasonably good control.

The informant deals also with the question of uncontrolled animals such as wild pigs and cattle.

Other weeds which cause trouble are Kaumoce, and Blue Rat Tail. Mile-a-minute is found to check the growth of cut Guava but in young coconuts it is itself a source of trouble. Kaumoce and Sensitive Grass are not troublesome weeds in mature coconuts, but need attention on cultivated land. Kaumoce is regarded as a valuable green manure.

NAITASIRI PROVINCE.

Three replies were received. The province is subject to heavy rainfall. Sugar cane is the principal crop, but general cultivation and dairy farming are carried on. Cultivation on arable land reduces considerably the trouble experienced with noxious weeds. In the cane lands, Para Grass, Sensitive Grass, Mile-a-minute and Solanum obtain a hold when land is left fallow, but all are very easily controlled by cultivation. The greater portion of the hill land is not under cultivation and is infested with Koster's Curse, Guava, Mile-a-minute, Solanum and other vigorous weeds which have ousted Para and other grasses of value to dairymen. The hill soils vary considerably, but poor light clay is predominant. Methods of control on areas under cultivation for cane are ploughing and harrowing, but occasional patches of Solanum and Johnson Grass are dug out by hand.

The Colonial Sugar Refining Company Limited, has found that Koster's Curse can be controlled by ploughing and vigorous harrowing, as also can Para Grass. Lantana and Solanum may be partially controlled by cutting back and digging out. Sensitive Grass and Mile-a-minute can only be checked by hand weeding, but even then Mile-a-minute often gives considerable trouble in the cane crop, causing fallen stools and low quality cane.

The Methodist Mission at Davuilevu states that on their cultivated land the infestation of weeds is slight. There is heavy growth on uncultivated hills where Koster's Curse, Lantana, Solanum and Guava are met with. Para Grass has been found to check the growth of some weeds but as already observed this plant is itself regarded as a nuisance in certain areas. Stock are run in the Para Grass. Weeds are kept in check on closely cultivated land and in pasture by not permitting stock to eat down Para Grass to such an extent as to encourage the growth of weeds. Noxious weeds are said to be decreasing. Elephant Grass has been found to be keeping out weeds from hill areas. It is said to be easily controlled and is readily eaten by cattle and pigs. If cut down frequently the fresh shoots make excellent green food for poultry. The writer recommends that Elephant Grass should be planted on the hills for keeping down noxious weeds and thus extend the area available for cattle grazing. Solanum is kept in check by school children who are sent out on certain afternoons when the plant is flowering with instructions to slash. It is suggested that school children could with advantage be used more generally for this purpose during certain periods of the year.

In another area where grazing and crop raising are carried on Koster's Curse is the principal weed. Solanum and an unnamed burr occur to a small extent. Sensitive Grass is also met with. For periodical cropping the land is cleared by mowing and ploughing and for the establishment of pastures these operations are followed by the chopping of Para Grass which is disced in during wet weather. Ten acres badly affected with Koster's Curse and Sensitive Grass were cleaned by mowing and ploughing at a cost of £2 5s. per acre. Cutting and grubbing is said to cost more than three times as much. Little trouble is experienced in controlling weeds in arable lands, but to keep them down in pasture lands costs about 10s. per acre per annum. Weeds are said to be spreading in the district. A small root worm has been observed which appears to destroy a good deal of Koster's Curse on hill lands. Weeds are spread by cattle and birds. The methods practised for the control of Koster's Curse are mowing and burning followed by double ploughing and later by systematic grubbing. Solanum is kept in check by grubbing twice annually, Burr by grubbing in the autumn and Sensitive Grass by an annual mowing.

NADROGA PROVINCE.

Two replies were received. Weeds reported are Guava, Solanum, Nut Grass, and Koster's Curse, which are said to be increasing in the district on pasture lands, but diminishing on cultivated lands. Native land is the main breeding land for noxious weeds and general control is impossible on vacant lands even if supervised by a staff of inspectors backed up by the law. It is considered that no other practical methods of control except closer settlement and increased cultivation and greater care of pasture lands will be successful. The overwhelming argument against various methods of control is that there are not sufficient people in Fiji at present to cultivate all the land.

In cultivated land Guava is dug out with Demarara spades and mattocks by contract. Initial clearing costs £3 per acre. Weeds are kept in check on arable land by cultivation and in some pasture land by burning off in dry weather and digging out. Birds, such as Mynahs and Bulbuls spread Guava and Solanum, and cattle eat the Guava fruit and spread the seeds. Flood waters carry the weeds of Solanum and Koster's Curse. The only effective method for controlling Guava is burning-off and digging out stumps. This would appear also to apply to Solanum and Koster's Curse. In the case of Nut Grass a parasite found effective in Queensland has been mentioned but it is doubtful whether it would prove useful as land must be allowed to lie idle for a number of years, although it would be worth while to institute inquiries.

NADI PROVINCE.

One reply received. Sensitive Grass has been found troublesome in pine-apple land. Disc ploughing is utilised for initial clearing and the land is kept free from weeds by intense cultivation. Experience in cane growing in Queensland is said to have shown that the best method of controlling Sensitive Grass is by cultivation and spraying with a solution of arsenite of soda. The uncontrolled grazing of stock appears to be the principal means of spreading weeds and it is recommended that graziers should be compelled to keep their lands free from noxious weeds. Vacant lands owned by absentees form breeding grounds for weeds which spread rapidly and control by resident cultivators is rendered considerably more difficult.

SERUA PROVINCE.

One reply received. Large areas of unoccupied European land are covered by a dense growth of Koster's Curse and some land which is nominally occupied is infested with noxious weeds, particularly Koster's Curse, the seeds of which are spread by the mongoose and birds. The cost of clearing noxious weeds is much heavier near the boundaries of areas used for pasture purposes than on those paddocks which are more distant from the centres of infestation. Koster's Curse appears to be the most serious weed encountered and so long as large areas remain without any attempt to control the weeds, the task of those who are endeavouring to keep their land clear will be rendered difficult and expensive.

REWA PROVINCE.

One reply received. Weeds encountered on pasture land are Koster's Curse, Solanum and Lantana, which are sparse on account of the control exercised. Principal crops grown are sugar and rice and a little maize. The weeds are kept down by constant cultivation. Initial clearing of noxious weeds varies from 30s. to 53s. per acre according to the density of the growth. In arable lands weeds are kept under control by cultivation and in pasture land by constant cutting and rooting out. Unused areas are left until required as the cost of control of weeds is too excessive to do otherwise.

Control of weeds in pasture lands costs £1 per acre per annum. Solanum is said to be increasing rapidly. Koster's Curse and Lantana apparently are stationary. Heavy growth of Mile-a-minute has been observed to check the spread of Koster's Curse, but appears to have no effect on Solanum or Lantana. Birds cause re-infestation of cleared lands rapidly. Pasture land once thoroughly cleared of weeds can be kept practically clear from them by one man to every 50 acres.

RA PROVINCE.

The following extract is taken from the one reply received from the Manager of the Colonial Sugar Refining Company Limited, Penang:—

The area held by us here is about 18,000 acres of which about 4,500 acres are, or will be cultivated for cane, and the balance is hill land of which perhaps half could be used for grazing. The main crop is cane, though small areas are devoted to rice and maize.

The only noxious weeds of importance here are Ellington Curse and Guava and neither of these give any trouble on the cultivated areas. Koster's Curse and Solanum I have not seen in the district. A couple of years ago there was a small amount of Noogoora Burr, but this has been destroyed and is not now in evidence.

Ellington Curse is fairly dense on some of the steeper and stonier hills at Ellington but outside that area it is sparse to negligible.

Ellington Curse seems to prefer good soil but grows equally well on stony hills and on the sandy soil of the sea shore just above tide reach.

Guava is dense on some of the hills nearer Penang. It prefers good soil and its growth is of small account on the distinctly poorer soils.

The only method which seems to avail against Ellington Curse or Guava is to grub it out, roots and all.

We have done no clearing of either growth ourselves and cannot compare the probable cost. Considerable areas have been cleared by our tenants, however, and they invariably cut down the bushes and grub out the roots with mattocks. There is no sign of either weed returning on the cultivated land.

In my opinion Guava is a much greater nuisance than Ellington Curse because birds and cattle carry the seed which is quickly re-sown on cleared land; but neither birds nor cattle appear to touch the seeds of Ellington Curse so that the growth can only spread slowly around the parent plant.

Ellington Curse, however, has large thorns which are to a certain extent poisonous and on this account it is a bad weed to have in cattle country.

COLO NORTH PROVINCE.

One reply received, in respect of grazing land. Guava is the principal serious weed met with. Effective clearing has been done by cutting above the ground when the sap is down and poisoning with a solution of arsenite of soda applied to the freshly cut stump with a paint brush. The cost of clearing and cultivating land heavily infested with Guava is £3 10s. per acre. Ellington Curse is also met with and is kept under control by constant grubbing. Guava is said to be increasing alarmingly throughout the whole district. The ripe fruit is eaten by horses, cattle, pigs and a number of birds, and the seeds are spread by the droppings. Young plants are observed coming up freely in the wet season and apparently have no natural enemies. The main solution in regard to Guava seems to be the prevention of fruiting. Ellington Curse is confined to the coastal areas and its spread is much more gradual. Solanum and Lantana are found in the mountain area and along the water ways. Seeds of Solanum are spread by birds. The spread of Guava on grazing land is regarded as a serious economic problem. It is suggested that Government should let grazing land on a longer lease and make the control of noxious weeds a condition of the lease. Short leases and high rentals are regarded as a contributing factor to the invasion of weeds. The writer states that in his view there are some one and a half million acres of grazing land within sixteen miles of the coast between Vitilevu Bay and Sigatoka and that of this one quarter is infested with Guava. The possibilities of biological control should be explored. Fijians should be debarred from giving yearly terms for the occupation of land to any person for the purpose of grazing, as in such cases occupants move at the end of two or three years and leave the land infested with weeds which gradually infest the surrounding areas.

TAILEVU PROVINCE.

Ten replies were received. The principal weeds are Guava, Koster's Curse, Solanum, Burr, Kaumoce and Blue Rat Tail. Koster's Curse has

obtained a firm hold in the district and may be observed growing luxuriantly on large areas. Hand clearing, followed by burning, ploughing and harrowing is used to clear land of noxious weeds, for the establishment of pastures. Direct ploughing by a tractor and disc plough has recently been practised, but it is early to state whether this is an effective method unless followed by further clearing of secondary growth. Noxious weeds in the pastures of the dairy farms are a constant source of trouble and expense to the dairymen. The annual cost of maintaining pastures reasonably free from weeds ranges from about 7s. 6d. to £1 per acre per annum. Initial clearing of noxious weeds costs from 30s. to £3 per acre, according to the degree of infestation and the nature of the weeds. Koster's Curse is kept under partial control in pasture by cutting out with knives, pulling out the roots or grubbing with a mattock. It is suggested that a grass of good quality that will cover the ground in a close mat will assist considerably in controlling weeds. Sensitive Plant it is said by some dairy farmers to check very considerably the growth of Koster's Curse. The application of manures to pastures at the proper time encourages the growth of grasses at a greater rate than that of weeds and helps to keep the latter under control. Birds and the mongoose are the principal agents that cause the spread of noxious weeds. One writer states that steps should be taken to exterminate wild pigeons and that in any case they should be no longer protected.

A letter dealing in general terms with this subject was received from one of the Firms who control large interests in the Colony, pointing out that the great danger from noxious weeds in the majority of cases lies in the unused or partly used native land. This increases the difficulty of the problem enormously because even if Government took steps by statute to enforce their labour the available Fijian population is not large enough to deal with periodical weeding of their land and moreover, the value of the great portion of that land is so low as to make it impossible to recoup the cost of controlling the weeds growing on it. The problem is, however, complicated by the continued fall in the market value of copra, which has rendered it necessary to reduce plantation costs to the lowest possible limit with the result that periodical weeding has been one of the first services to be sacrificed.

SUMMARY.

A survey of the question of noxious weeds in Fiji indicates that there are some five aspects of the problem. These are:—

Weeds in—

(*a*) cultivated land;
(*b*) grazing areas;
(*c*) dairy farms;
(*d*) coconut plantations;
(*e*) unoccupied native and other land.

The control of noxious weeds in arable land is not a serious problem, although the annual cost is increased because of the large areas infested with weeds contiguous thereto. In grazing land where large areas are stocked with cattle at the rate of one beast to several acres, weeds are increasing and the available grass land is being reduced at a rapid rate by the spread of Guava and other objectionable plants. The control of weeds in such areas is undoubtedly a very difficult problem and the constant cutting and grubbing which can be practised in dairy farming areas where intensive grazing is carried on are impracticable in other grazing areas.

In the dairying areas it appears possible without great difficulty to keep pasture land reasonably free from weeds by constant attention, but the cost

of this work is a heavy charge on the dairy farmer and difficulties are again increased by adjacent heavily infested areas which re-infest the pasture lands rapidly.

In well-run coconut plantations periodical weeding is normally practised, but there can be no doubt that the fall in the value of copra will lead to a considerable curtailment of the expenditure for upkeep and maintenance of plantations, and weeds may rapidly obtain a firm hold in areas which have for many years been reasonably clear.

Vacant lands, many of which have at some time or other been under cultivation, are a constant menace to every phase of agriculture in the Colony. As has been seen the fruits of many of the weeds are eaten by birds, mongoose and other animals and spread by their excrements. Though there seems little hope of justifying the enormous cost of clearing these vacant lands of weeds or even of keeping the heavy growth under reasonable control, it would appear advisable to limit as far as possible the agencies which distribute the seeds.

From the information available it appears that Guava may be regarded as the most serious weed in Fiji. It is spread easily, grows rapidly and if unchecked develops into a sturdy tree which is costly to cut out, although the wood is a valuable fuel and makes excellent charcoal. Koster's Curse grows luxuriantly and spreads rapidly but appears not to deplete the soil of plant food to an undue extent. It can be dealt with without great difficulty on land which it is desired to bring under cultivation, but is a more difficult problem in dairy lands where it springs up rapidly if care is not constantly exercised.

Lantana in several districts is being kept under control biologically by the insects imported from Hawaii and the more general distribution of these insects as colonies become available will undoubtedly contribute to the destruction of this weed. Prickly Solanum appears to be increasing in many districts. It is of sturdy and luxuriant growth and fruits heavily. Although cattle occasionally eat it when more attractive fodder is not available they cannot be said to keep it under any degree of control. Blue Rat Tail is a nuisance wherever found and simple cutting is useless in endeavouring to control it. It must be uprooted completely if it is desired to eradicate it from any area.

It appears impossible to institute one method for the complete control of the more important noxious weeds of the Colony. Methods must be adapted to the principal needs of the various agricultural pursuits, and for this reason it is hardly necessary to consider the problem of arable lands where constant cultivation is necessarily practised in connection with the growing of crops. It will therefore be convenient to consider land which falls into the three catagories—

(*a*) dairy land;
(*b*) land under permanent crops, *e.g.*, coconuts;
(*c*) vacant land.

Apart from the methods already briefly discussed there appear to be three possibilities—

(1) biological control;
(2) destruction of plants by spraying;
(3) the use of beneficial cover crops, or permanent crops which will repay the cost of their planting during the early stages of growth.

In connection with (3), the matter of afforestation arises.

(*To be continued.*)

COPRA DRIERS—REPORT OF VISIT TO WESTERN SAMOA.

By A. C. Barnes, F.I.C., B.Sc., A.M.I.Ch.E.

INTRODUCTION.

The primary object of my visit to Western Samoa was to examine the types of copra drier in use on the New Zealand Reparation Estates. The opportunity was taken of visiting other plantations where artificial driers were in use, and of investigating to some extent the manner in which the copra industry was conducted on the Estates. In addition, inquiries were made into the present position and prospects of the banana industry, a subject which has been reported upon separately.

2. I received every possible assistance from Officers of the Government of Western Samoa, and of the Reparation Estates, and was afforded opportunities for making as complete an investigation as was permitted by the limited time available. The Manager of the Estates accompanied me on visits to the plantations under his charge on four days, and supplemented the observations I was thus able to make by supplying detailed information and plans from his records.

PLANTATIONS VISITED.

3. The Reparation Estates consist of a number of plantations, of which I visited three, Vaitele, Vailele, and Mulifanua. A drier belonging to Mr. Mauritz, and a small village drier erected by the Government for native use were also inspected. Visits were made to the estates of Mr. Brighouse and Mr. Cobcroft, on both of which driers were in operation.

THE COPRA INDUSTRY ON THE REPARATION ESTATES.

4. Before proceeding to describe in detail the various types of copra driers examined, it may be well to deal briefly with the general manner in which the production of copra is carried out on the Estates.

5. The coconut plantations are well laid out and the trees have been regularly planted, 30 ft. by 30 ft. square. The soil is volcanic and rocky, volcanic stones being in evidence on most of the areas, so that mechanical cultivation is impossible and hand weeding difficult. Ground cover consists mainly of sensitive plant (*Mimosa pudica*) and cattle are run on all plantations. They successfully keep down the growth and form a valuable source of revenue. The plantations carry about one animal per acre.

6. A recent muster gave returns as follows:—

Plantation.	*Area.*	*Stock.*
Vaitele	1,473 acres	1,660 cattle.
		40 working bullocks.
		45 donkeys.
Mulifanua	4,200 acres	4,277 cattle.

7. The plantations are well fenced and subdivisions are further divided into grazing areas of convenient size. Iron spiral fencing posts are being used to an increasing extent. They are cheap, of light weight and strong. The cost *ex* New Zealand landed in Samoa is 1s. 6½d. per post, but I am informed that they can be imported direct from England to Fiji at a landed cost of 1s. 2½d.

8. Good roads exist on all the plantations and greatly facilitate the work of nut collection, general transport and communication. Though

bullock carts are largely used at present, some motor trucks are employed, and it is understood that motor vehicles will be used to an increasing extent in the future.

9. The Estates are divided into units of convenient size for ease of working, and an artificial drier is located in each subdivision. The collection of nuts is carried on by groups of coolies who work systematically through the area in such a manner that a complete cycle occupies about six weeks. Donkeys with pannier baskets are used to carry the nuts to the roads, where they are dumped, loaded into bullock waggons and thus carried to the cutting station situated near the drier. Here the nuts are placed under shelter in readiness for the cutters, who are divided into two groups, one of which spilts the nuts while the other cuts out the copra and places it into boxes for transference to the drier. The floor of the portion in which the nuts are split open is covered with sections of coconut tree trunks lying transversely and in this manner the nuts are conveniently chopped open by an axe while the " milk " runs down between the logs into a drain.

10. The daily tasks for these operations are as follow:—

	Nuts per man per day.
Collecting	1,200
Chopping	4,000/4,300
Cutting out copra	600 lb (net)

11. The green copra is transferred to the drier with a minimum of delay and there can be no doubt that this contributes largely to the high standard of quality of the product.

TYPES OF COPRA DRIERS.

12. On the Reparation Estates two main types of driers are in operation and may be referred to respectively as the German Drier and the Chula. Different examples of each of these types are in use and will be described separately.

13. The German driers are essentially of the hot air type with natural draught. They consist of a masonry chamber over which is constructed the drier proper which includes a drying chamber and a loading and discharging platform. The driers vary in size and capacity and although there are several of them no two are alike. It is evident that when they were constructed certain variations were resorted to, possibly with the object of determining the best design for final adoption.

14. At one end of the masonry chamber below ground level, is a fire-box with an extended combustion section, from which a rising pipe leads to the air heating pipes and thence to the chimney, which is erected outside the building. The air heating pipes are arranged at different levels, and are so constructed that their ends are set in the walls of the chamber and can be opened for cleaning. Connection between successive pipes (or flues) is made by short transverse sections of the same diameter of pipe.

15. At ground level, the chamber is pierced by a number of apertures which are capable of being opened and closed at will, thus allowing ingress of cold air which is subsequently heated by the pipes and rises into the drying chamber, finally passing out through a ventilator or ventilators in the roof.

16. Firing is affected by coconut husks with attached shells. Practice has shown that the fuel from a given quantity of nuts is more than sufficient to dry the copra from these nuts. The design is shown in the diagram.

Detailed plans were furnished by the Manager of the Reparation Estates, and may be consulted at the offices of the Agricultural Department. It will be convenient for this purpose of the report to describe a two-compartment drier.

17. The fire-well is 6 ft. deep and furnace 4 ft. 6 in. long to the face of the sloping fire brick end, with an ash-pit 18 in. deep below the fire bars. A 12 in. aperture above the fire brick face leads into an extended combustion chamber, which has a cleaning well at the far end. From this a rising pipe about 18 in. in diameter leads to a level heating pipe within the masonry chamber and to a further inclined pipe passing in the opposite direction which joins the chimney.

18. Usually the air heating pipes are fixed longitudinally under the drying compartments, one pipe running underneath each compartment. In one instance, however, these pipes are set transversely, and it is stated that this particular drier gives better results than the others.

19. The masonry chamber is 7 ft. 6 in. high, 7 ft. 6 in. wide and 15 ft. 9 in. long. The centre line of the inclined heating pipe is 3 ft. 9 in. above ground level at one end, and 4 ft. 3 in. at the other. The bottom of the drying chamber is open. The necessary structural rigidity is secured by a heavy rail, laid longitudinally, carrying the centre wall of the two compartments.

20. Each compartment measures 3 ft. 1 in. from wall to wall and is 9 ft. 6 in. high and 16 ft. 3 in. long. Hardwood runners for 18 tiers of trays in each compartment are fitted to the wooden walls which are hollow and filled with sand to secure heat insulation. The trays themselves are 3 ft. by 2 ft. with wooden frames covered with half-inch square mesh wire. On the bottom, hardwood strips are nailed over the wire mesh to facilitate the movement of the trays within the drier. The substitution of hardwood runners on the walls of the drying chamber with angle iron has been found effective in facilitating working and reducing wear.

21. It will thus be seen that each compartment is capable of carrying 144 trays if completely filled, but in practice the lowest trays are covered with fine mesh netting in order to catch small particles of copra and dust which might otherwise fall on the heated pipes and add to the risk of fire. The first two or three runners are generally left devoid of trays. During the course of the drying the position of the trays is changed from time to time. A long pole with a hook on the end is used to pull the trays from the far end of the drying chamber.

23. The chambers are closed completely at one end, doors being placed at the other, where the handling, changing and discharging takes place entirely. The design would be improved by fitting doors at both ends, but in this case the building in which the drier is housed would need to be extended. In the middle of the roof of the drying chamber is situated a transverse ventilator 6 ft. 8 in. long by 2 ft. wide and 7 ft. high.

24. The drying chamber is housed inside the building which is floored at both sides and one end. The floor of this is 7 ft. 6 in. above ground level and access to it is afforded by steps. It will thus be seen that the disadvantage of the drier is that the floor of the loading platform is considerably above ground level and the green copra and the dried copra have to be carried up and down respectively. To construct this type of drier in such a manner that the loading platform is at ground level would involve costly excavation.

25. The space on each side of the drying chamber is utilised for bagging the discharged dry copra without interfering with the normal working of the drier. The capacities of driers of this type are as follows:—

Two-compartment	..	2,500/3,000 lb green copra.
Three-compartment	..	4,000/4,500 ,,
Four-compartment	..	5,000/6,000 ,,

26. The time required for drying is 30–36 hours. The product is clean, white and apparently of excellent quality. The results of analyses of samples taken from these driers are given in the Appendix.

27. The estimated cost of erection of a three-compartment drier is £550, and the cost of drying, including all charges is £1 0s. 5d. per ton. This is worked out as follows:—

Depreciation buildings, 5 per cent...	£27	10	0
Repairs, &c. (estimated)	20	0	0
Flue pipes, furnace, smoke-stack and renewals (Total £60 cost for 3 years) ..	20	0	0
Labour—1 night and 1 day boy	94	0	0
Repat. and Rec. charges	15	0	0
Renewal trays and runners	10	0	0
Interest—6 per cent. on capital	33	0	0
Overhead plantation based on ⅓ labour cost ..	31	0	0
	250	10	0
Kerosene (lights)	5	0	0
Annual cost	£255	10	0

Four dryings a week—270 tons p.a.; allow 1 month p.a. for repairs—250 tons=£1 0s. 5d. per ton for maximum drying.

NEW TYPE OF HOT AIR DRIER.

28. An interesting drier of somewhat unusual construction has been erected by Mr. Mauritz for drying green copra purchased from natives. This again is a hot air drier, the heating being effected by a furnace with flue or flues passing through a longitudinal air mixing chamber. Above this chamber on one side, the drying chamber is constructed consisting of a large sloping wooden box, divided into compartments. Hot air from the air mixing chamber is admitted through a vent at the lower end of each compartment and rising through the compartment emerges through a ventilator door which can be adjusted to control the rate of passage of air as well as the rate of drying. The drier that I examined had eight compartments each of which was 3 ft. wide, 8 ft. long and about 3 ft. in height. Five angle iron runners were fitted on each side of the compartment and small trays about 3 ft. by 2 ft. covered with wire mesh were used to hold the copra. The drying chamber is set at a slope of 12½ deg. and charging and discharging is effected at the upper end, the more distant trays being moved by means of a pole with a hook at the end as already described. The capacity of the drier is 2,500 lb of green copra, equivalent approximately to 1,500 lb of dry. The period required to dry is about 24 hours. I was very much struck with this drier, which is of very simple construction and can be so built that charging and discharging takes place at a convenient height above ground level. The supply of hot air to each compartment can be regulated both by the door at the upper end as well as by slides over the hot air ducts at the lower end. Deflecting places are fitted at the lower

end in order to ensure an adequate supply of hot air to the lower trays. It would be possible to construct such a drier with two wings set over the same mixing chamber with adequate heating by one furnace. I was unable to ascertain the cost of construction, but consider that it would not be more than two-thirds of that required for a three-compartment German type of drier having a similar capacity. The drying chamber is lined in each compartment with compressed megasse, a material which possesses heat insulation properties, and which is cheap and convenient to use for such a purpose. Hot air circulation is secured by natural draught only and no mechanical appliance of any kind is necessary for the operation of the drier. The slope of the drying compartments adds somewhat to the labour of discharging the dried copra, but as the trays are light and carry only a few pounds of copra each, this is not a serious disadvantage. (see diagram).

HOT WATER DRIERS.

29. Several hot water driers were installed by the Germans on various plantations in Samoa. The essential difference between them and the hot air drier described in the first instance is that the heating of the air for drying is effected by a system of hot water pipes placed underneath the drying compartments and connected to a water heater at the side. In practice it has been found that these give very satisfactory service. The cost of upkeep is low and temperature control is more readily effected than with the ordinary hot air type. I was unable to ascertain the cost of erection of a drier of given size operated by hot water. Particulars of a small one installed by the Samoan Government for village use are given in the Appendix.

TUNNEL DRIER.

30. Mr. Mauritz also has a tunnel drier with hot air circulation effected by a power driven fan. So far as I could gather this drier gives excellent service, but it appears to me to be unsuitable for general adoption in view of the cost of construction and the fact that it requires power and therefore some skilled mechanical attention to operate it.

31. It was interesting to observe that Mr. Mauritz had installed the new sloping drier over the same air heating and mixing chamber as is used for the tunnel drier, and that he used the new drier in preference to the old one,

GORDON DRIER.

32. I had the opportunity of inspecting a Gordon Drier used in cocoa drying on the Estate of Mr. Coberoft. As, however, this machine was not of particular interest from the point of view of copra drying, it is not necessary to describe it.

CHULA DRIERS.

33. Two different types are in use on the Reparation Estates. A mechanically operated air circulation fan is common to both, except that the power used is different in each case. The Chula drier at Vailele is a so-called one-way drier; that is, the hot air circulates only in one direction and no means of reversing the air current are available. The copra is dried in bulk, and in practice it has been found that the material with which the hot air first comes in contact is dried comparatively rapidly, while that through which the air finally passes still has too high a content of moisture when the other is dry.

34. To overcome this difficulty a longitudinal partition has been put in the drying chamber so as to divide it into two equal parts. The system of working is such that the dried copra from the lower compartment is

discharged when ready and that from the upper is allowed to pass into the lower one, the upper one being again charged with green copra. In comparison with the other types of driers in use on the plantations, the Chula is very uneconomical. Drying costs are considerably increased by the necessity for skilled attention to the engine which drives the fan, and it is found that the rate of depreciation is high and repairs cost an excessive amount. The furnace, which is an essential part of the drier, appears to burn out fairly rapidly and to reduce costs of repairs and renewals a separate furnace has, in one case, been built.

35. At Mulifanua, there is a two-way Chula drier in which a more even drying of the copra is effected by reversing the hot air current by means of a slide operated above the drier. In this case a steam engine is used to drive the fan, whereas at Vailele an internal combustion engine is employed.

36. The capacity of the one-way drier is 2,500/3,000 lb of green copra and of the two-way drier 5,000/6,000 lb. Both machines take from 36/40 hours to dry one charge. Roughly, the cost of erection of a two-layer one-way drier of the stated capacity, with engine, is £800. The estimated cost of the necessary building in which to house it is £100. Details of the cost of drying are set out in the Appendix.

GENERAL REVIEW OF METHODS OF DRYING IN SAMOA.

37. Summarising the results of my observations which are supported by some knowledge of types of driers in use in other places, I put the driers described in the following relative order of preference, taking into account efficiency, ease of working, initial cost of erection, upkeep, depreciation and repairs and suitability for conditions in Fiji:—

(1) The inclined chamber drier.
(2) German type direct air heated drier.
(3) German type hot water air heated drier.
(4) Chula two-way drier.
(5) Chula one-way drier.

38. In my view the inclined chamber drier represents a very considerable advance on anything I have yet seen of its capacity, though I am of opinion that a number of improvements could, with advantage, be effected.

GENERAL ECONOMICS OF THE PRODUCTION OF COPRA ON THE REPARATION ESTATES, WESTERN SAMOA.

39. *Yield per acre.*—As elsewhere, there is a considerable variation in the yield per acre per annum of copra on the Estates in Samoa. Records kept over the past six or seven years show that the yield ranges from 537 lb to 1,056 lb. The table below gives the highest and lowest figures recorded during that period on three of the Estates:—

	Highest.	*Lowest.*
Mulifanua ..	1,857 lb per acre	1,686 lb per acre.
Vaitele	1,056 ,,	626 ,,
Vailele	793 ,,	537 ,,

40. *Costs of production.*—The average number of units of labour required to produce one ton of dry copra was 40 in 1929. This includes labour for the cattle, which are run as an integral part of the plantation working.

41. The cost of copra at Apia is given as £9 9s. 4d. per ton f.o.b.—according to the detailed statement in the Appendix. Transport to Apia, insurance and the cost of bags and twine have been included. It should be

observed that the figures given include charges in respect of the stock industry and that the profits on sales of cattle have been deducted from the total cost thus arrived at.

41. *Marketing.*—Copra produced on the Reparation Estates is marketed in London, Hull and Hamburg. Freight costs £3 7s. 6d. per ton weight. Recent market quotations are:—

Date.	*Plantation.*	*Crown Estates.*
23/11/29	£21 10 0	£22 10 0
4/1/30	21 12 6	22 10 0
1/2/30	21 12 6	22 15 0
5/4/30	20 15 0	21 5 0
5/5/30	21 0 0	21 12 6
14/6/30	18 5 0	19 0 0

APPENDIX.

RESULTS OF ANALYSES OF SAMOAN COPRA.

Sample	Moisture in vacuum oven at 100°C.	Oil on moisture free copra.	Oil on original copra.	Free fatty acid (Lauric).
1. Vaitele, Mauga Station ..	7·76	67·53	62·29	0·30
2. Vaitele, Vaitele Station, drying completed 15/5/30, sampled 26/5/30	6·07	67·68	63·57	0·39
3. Mr. Mauritz	6·73	65·45	61·05	0·64
4. Vaitele, Suga Station, Chula, 26/5/30	7·54	69·50	64·26	0·27

The samples were in splendid condition and showed little sign of mould action. Samples Nos. 1 and 2, plantation copra, dried in German hot air driers. Sample No. 3, native copra, dried in inclined chamber drier. Sample No. 4, plantation copra, dried in one-way Chula drier. It should be observed that the moisture content has been determined in a vacuum oven which gives more accurate results then are obtained by the usual stem oven method when vegetable oil bearing materials are being examined. The figures may appear to be higher than normal in consequence. The analyses were performed by Mr. W. J. Blackie, M.Sc., Government Chemist.

PARTICULARS OF HOT WATER DRIER ERECTED AT VAIUSU VILLAGE.

Drying Chambers (3) ..	2 ft. 6 in. (approx.) by 5 ft. by 6 ft. high.
Runners	5 in. centres (approx.). (14 sets to each compartment).
Trays	28 per compartment.
Ventilator	5 ft. by 2 ft. (with control).
Heating pipes	128 feet of 2½ in. bore pipes with radiating fins, in two banks.

CHULA ONE-WAY.

Capital cost erected £800 with engine, building necessary estimated at £100.

ANNUAL CHARGES.

Depreciation, Chula 10 per cent., engine 10 per cent. ..	£80 0 0
Building, 5 per cent.	5 0 0
Pipes, furnace, smoke stack renewals	15 0 0
Engine boy, day and night, at £6 per month each .. One boy for filling, &c. (Samoan)	200 0 0
Fuel, oil and repairs to engine	180 0 0
Interest on capital, 6 per cent.	54 0 0
Overhead at same basis as German	31 0 0
Kerosene..	5 0 0
	£570 0 0

Capacity, 2,500 lb wet; annual output, 125 tons; cost per ton, £4 11s. 2d.

CHULA TWO-WAY.

Cost Chula, £971 4s. 10d.; boiler, £348; total, £1,300.

ANNUAL CHARGES.

Depreciation buildings, 5 per cent.	£5	0	0
Chula and engine, 10 per cent.	130	0	0
Pipes, furnace, smoke stack renewals	25	0	0
Labour as one-way	200	0	0
Repairs engine, pulleys, shafting, belting, &c.	30	0	0
Lubricating oil	20	0	0
Interest on capital	78	0	0
Overhead on same basis	31	0	0
Kerosene	5	0	0
	£524	0	0

Capacity, 5,000 lb wet; time of drying, 36 to 40 hours; Annual output, 250 tons; cost per ton, £2 1s. 11d.

COST TON COPRA LANDED IN APIA YARD.

Vaitele; 476 tons; April 1st to March 31st, 1929–30.

Labour direct.	*Cost.*		
Beetle searching	0	8	4
Weeding	1	3	4
Donkey boys	0	18	5
Transport—Bullock waggons, &c.	0	11	4
Choppers—One boy to six choppers	0	4	10
Cutters (average, 518 lb	1	6	0
Drier boys	0	13	1
Bagging and loading	0	1	9
Cattle, mustering, branding, killing, &c.; water-supply, fencing, roading, horses, breaking donkeys and bullocks, messengers, motor lorry drivers, paddocks, servants	1	15	1
	£7	2	2
Stores, being supplies of tools, fencing material, timber, petrol, and all necessary materials for use on plantations	0	13	5
Apia charges, rates, taxes, telephones, drier repairs, repairs to motor lorries and other direct charges from Head Office	0	19	9
Management—Salaries of Manager and assistants	2	4	0
Depreciation—Overhead, &c., building, plant and machinery, vehicle, harness and saddlery, motor lorries, furniture and fittings, &c., head office overhead charges, stationery, &c., &c.	1	7	0
Total	12	6	4
Less profit on cattle	2	17	0
	£9	9	4

RHINOCEROS BEETLE—POSSIBILITY OF ACCIDENTAL IMPORTATION FROM SAMOA.

By T. H. C. Taylor, B.Sc.

The Rhinoceros Beetle (*Oryctes rhinoceros*, Linn) is widely distributed in the Tropics. It is a well known pest of coconuts in India, Ceylon, Malaya, the East Indies and the Philippines and many other countries.

2. The beetle appears to have been imported into Samoa in or about 1910 from Ceylon in boxes containing rubber stumps packed in soil and vegetable refuse. It soon became a pest of major importance in Samoa and has done much more damage there than in the Far East, where it is indigenous, presumably owing to the absence in Samoa of its natural enemies.

3. On account of the close proximity of Fiji and Samoa and of the direct shipping communication between them, there is a risk of the beetle being introduced into Fiji. This risk was first appreciated in 1912, when

F. P. Jepson, Government Entomologist in Fiji, visited Samoa to investigate the matter and published a report thereon (Department of Agriculture, Fiji, *Bulletin* No. 3). This report, together with others which have since been published elsewhere (notably in the Philippines) constituted a fairly complete account of the various stages and habits of the pest, a thorough knowledge of which is essential if the insect is to be kept out of Fiji.

4. Twenty years have elapsed since the Beetle first reached Samoa and it has not yet become established in Fiji, so the risk cannot be very great. Nevertheless, the risk is always present and it is doubtful whether the Regulations concerning ships arriving at Suva from Samoa have been sufficiently strict in the past to eliminate it completely. The absence of the beetle in Fiji is probably due more to good luck than good management.

5. The work of Jepson in Samoa and of Mackie in the Philippines shows that the beetles lay their eggs in rotting vegetable matter, chiefly in dead coconut trunks and stumps and in heaps of coconut leaves and husks. The egg stage covers about 12 days. The resulting grubs feed entirely upon dead vegetable matter of this nature and never attack healthy coconut palms. The duration of the larval stage is long, roughly five to six months. The subsequent pupal stage occupies five to six weeks. The life cycle, from egg to adult, therefore occupies about seven months. The damage to the coconut palms is due only to the adult beetles, not to the larvæ. The beetle are entirely nocturnal in their habits and are frequently attracted at night to lights in houses and on ships in port. (I have seen many beetles of a closely allied species at night in an hotel near the wharf at Samarai, New Guinea, and also occasionally in hotels in Java and Malaya.) The beetle feeds by boring into the head of a coconut palm, often cutting off the tops of young unopened leaves in the central shoot or "cabbage," and sometimes killing the tree outright. It never attacks opened leaves. On account of its large size, a single beetle can do a great deal of damage. The adult insect feeds not only upon coconuts but also on may other species of palms and it has even been reported to attack sugar cane. It probably lives for several weeks when an abundant food supply is available, and would certainly survive for several days without food.

6. It is clear that the insect might be brought to Fiji in the egg, larval, or pupal stage in vegetable matter, and it is very doubtful whether it would be destroyed by fumigation. It is therefore essential that all cargo and baggage from Samoa should be inspected extremely thoroughly on landing in Fiji. The importation of the early stages of the pest can be prevented in this way, but the possibility of the importation of the adult beetles remains, and is not so easy to eliminate. It is almost certain that the beetles occasionally fly to lights on board ships in Samoa, and it therefore seems probable that they are occasionally brought to Fiji, and will eventually become established unless every precaution is taken. It is impossible completely to eliminate the possibility of importing the adult beetles except by preventing ships from staying in port overnight, a measure which is probably too drastic to be justified; but if such ships were prevented from remaining alongside the wharf overnight, it is most unlikely that any beetles would fly ashore, partly on account of the lights on board and partly because there would be no palms sufficiently near to attract them. As a further precaution, I consider that all palms growing near the wharf should be cut down and that the accumulation of dead vegetable matter in the vicinity of the wharf should be reduced to an absolute minimum. The removal of all palms near the wharf would be fully justified in this connection, as a precaution not only against Rhinoceros Beetle, but also against other coconut pests.

THE EXTERMINATION OF THE RAT.

By H. R. SURRIDGE, A.R.C.Sc.(I), Government Agronomist.

IN view of the serious damage caused by the destruction of young nuts in our coconut plantations by rats and the damage to foodstuffs in houses, general stores, &c., a resumé of the various methods of control adopted in other countries should be of service to those interested in the extermination of this serious pest here in Fiji.

The literature on this subject is continually being added to, and the general public are gradually becoming aware of the seriousness of the rat menace to human life, health, and prosperity. That it is a menance to our lives is demonstrated by the tremendous loss of life in historical times in England, Europe and other countries, and at the present time in India, through the Bubonic plague. Health is endangered through the contamination of foodstuffs, whereby the minute organisms causing various diseases are passed on to us, *e.g.*, trichinosis, tapeworm, parasitic mange, and trypanosomasis (sleeping sickness).

Some authorities consider that dengue fever is distributed by the rat. It is certain that in some rat infested areas, notably in Athens (Greece), dengue is prevalent, whilst it is unknown in the clean areas. The same has also been noted in Natal, South Africa.

Prosperity is affected by the loss of foodstuffs destroyed and damaged by this pest, and by the damage to buildings, dams, ropes, &c., which, while apparently small, is not appreciated until a dam or a rope suddenly collapses, with possible loss of life. Owing to the general character of such damage, it is not apparent to the public. Merchants, in assessing their profits, realise that a considerable loss is due to rats, and so regulate their prices as to cover such losses. This might be termed " the indirect taxation by the rat," since the levy of the rat is passed on to an unsuspecting and unthinking public. If such losses could be obviated by the extermination of rats and mice, the general cost of living would be somewhat reduced, the people's health safeguarded, and the risks of epidemics minimised.

Consideration of the three points just briefly discussed shows that the activities of the rat spell loss of life, health and money to the human race.

History.—The rat, like the poor, is " with us always," and according to historical records, has always been with us, and always as a menace. In ancient Egypt its destructiveness to foodstuffs was such that the Egyptians, appreciating the cat as a natural protector of grain or foodstuffs against the depredations of rats and mice, deified the Cat and worshipped it accordingly. Most of the plagues of history, which have caused grave loss of human life, can be traced to the rat as the carrier and distributor of the fatal bacillus, the most common being the famous " Black death " or " Bubonic plague " bacillus. With such a record, the slogan should be " kill that rat."

Varieties.—The varieties of rat most common in these islands are:—

(*a*) The Brown or Hanoverian rat (*Rattus norvegicus*), probably brought here by ships, either to the various ports, or when such vessels have been wrecked and cast ashore.

(*b*) The Alexandrian rat, (*Rattus alexandrinus*), the fur of which is longer and lighter in colour than in the case of the brown rat.

Mice are just as obnoxious as rats, but as they are smaller and not so fierce, the danger through food contamination by them is apt to be forgotten.

Legislation.—In Great Britain and other countries, legislation has been enforced, making it an offence to harbour rats or mice on one's premises, and fines are imposed on those contravening the law. Local authorities and the Ministry of Agriculture in Great Britain organise annually what is termed "rat week." This is one week of the year set aside for rat destruction, and the time chosen is that when the rat migrates from the field to the houses, buildings, towns, &c. In cold countries such migratory movements occur, there being two periods in the year for the rat. The first is early in spring when the migration is from the towns, houses, &c., to the field, the second in late autumn when the reverse movement occurs.

Here in Fiji, owing to climatic conditions, there is no clear differentiation between summer and winter, with the result that no migratory movements, similar to those of cold countries appear to occur. It has been noted however, in coconut plantations, that rat damage appears to be more intense during the dry season than during the wet season, thereby suggesting that a certain amount of migration from the ground to the trees and vice versa occurs between the two seasons. Whether there is actually a definite migration at a more or less definite time has not yet been noted. This matter requires investigation, for if such a movement does occur, then the knowledge of it would assist the institution of measures of control.

Control Measures.—Measures of control are not easy to suggest, since many that are suggested are also fatal to human beings, domestic animals and birds. Therefore, in considering control measures, it is necessary to devise means which, if possible, are fatal to the enemy only. Roughly there are four possible measures of control, three which are more or less in common practice, and one which while the ideal method, has not yet been perfected. The methods in use are as follows:—(1) natural enemies, (2) trapping, (3) virus, (4) poisons.

(1) *Natural Enemies.*—These include dogs, cats, mongoose, owls, the kestrel, magpies, snakes, and last but not least, the rat itself. Most of us are familiar with the dog, cat, mongoose, &c., as rat destroyers, but few appreciate the use which can be made of the male rat as an exterminator of his own kind.

Of the natural enemies named, the mongoose, in Fiji, is perhaps the least appreciated, owing to its habit of apparently preferring one's poultry to rats. It is possible however to utilise the mongoose in islands where rats are prevalent, but to which the mongoose has not been introduced. This may be accomplished by the expedient of trapping the mongoose, retaining the males and liberating them (males only) on those islands at present suffering from the pest. Such a scheme should result in the destruction of the rats, and the ultimate death of the mongoose. To attain such an end, it should be possible to breed the mongoose in captivity, to secure the males required.

Our experience with owls is limited, but given the right breed of owl, once these are established, they will exercise wonderful control over the rat. Mr. Moore Hogarth, in his book, *The Rat—A World Menace*, gives an instance where an owl with young had destroyed, in one night, 19 young rats and 27 mice as well as other vermin.

The kestrel and the magpie also account for a considerable number of these vermin, whilst certain snakes, harmless to human beings, are excellent in cleaning up rat infested areas. It is unfortunate that here in Fiji such snakes are rare, owing it is believed, to the activities of the mongoose.

Finally, there is the rat itself to be considered as its own exterminator. Two methods are possible, and these can be combined to form a very useful and effective measure of control.

The Rodier Method named after its inventor, an Australian, Mr. W. Rodier, is briefly to catch the rats alive, destroy the females, release the males, recording the number of females destroyed, and for the purpose of identification, cutting off half the tail of each male rat released.

The theory of this method is that under normal conditions the rats live in a polygamous state, which condition is conducive to prolific reproduction. Releasing the males and destroying the females tends to bring about a monogamous state, which state tends to restrict reproduction, by the males harassing the females, breaking up the nests, and destroying the young. Therefore the greater the number of males the quicker the extermination of the rat.

The second method is to foster the male rat's cannibalistic tendencies. Catch the rats alive, as previously suggested, but before releasing the males, half starve them, and then feed them with rat flesh. After a few days on this diet, release them. Such rats will prefer rat flesh to other foodstuffs with the result that they will fiercely raid the nests and destroy the young, as well as destroy the young rats that have already left the nest.

This latter method has been tried out by the writer, in the neighbourhood of farm buildings, with good results. It has also been stated to be effective on ships (ref.: *The Rat—A World Menace*, page 95).

(2) *Trapping.*—This can be accomplished by using the ordinary wire traps, for live catching, or the popular "break back," the rat-gin, &c. Two very useful traps which can be made at home are—

(*a*) sink a barrel, cover the top with strong paper and place bait in the centre of the paper for three or four nights. Then slit the paper in the shape of a cross, place as usual. The rats in getting at the bait will fall into the barrel;

(*b*) partly fill a bucket with water, and then fill up with corks to about 4 or 5 corks deep. This, placed between the rats and the bait, will compel the rats to cross the bucket, so that the corks will take the first weight of the rat but not the full weight, with the result that the rat falls through the corks and is drowned.

Another type of trap, which however is expensive, is made by using "Rat-lime" or a similar preparation. This is spread on a board, the bait being placed in the centre, or possibly the lime could be spread around the trunks of trees, one-eighth of an inch thick and about a foot wide. The rats in trying to get to the bait get stuck in the lime, and in struggling to free themselves get the nose or mouth embedded in the mixture and are suffocated.

(3) *Virus.*—The use of a contagious virus is probably the ideal method of rat extermination. Unfortunately, no virus preparation has yet been found which will automatically destroy the rat and not infect other animals including human beings.

Various preparations are on the market, which contain a virus and a poison so that their efficiency is probably due more to the poison than to the bacillus included in the preparation.

(4) *Poison Baits.*—Various poisons can be made use of, but the difficulty, when setting poisoned baits in the field or elsewhere, is to ensure that domestic and other animals will not get those baits, with fatal results. Two substances are in favour, one, Barium Carbonate, which is poisonous to rats, human beings and animals generally, the other, Red Squill Powder, which appears to be fatal *only* to rats, domestic animals and others not being affected by the amounts used.

(1) *Barium Carbonate.*—This is one of the most efficient of poisons, provided it is mixed with the right base. The British Ministry of Agriculture recommend a one-in-four mixture. Some maintain that a one-in-seven is strong enough. Barium Carbonate is a heavy white powder, mildly poisonous, tasteless, odourless, slow in action and inexpensive. While poisonous to rats, it is also poisonous to other animals so that great care must be exercised when distributing the baits.

To prepare the baits, all the ingredients must be thoroughly mixed, and if the baiting is done during dry weather, add sufficient water to make the baits rather mushy, since such baits are more attractive to the rat, particularly when water is not readily available. A variety of baits, used separately, gives the rat a free choice and enhances the chances of the baits being taken.

When mixing or laying baits, it is useful to keep the hands oiled with coconut oil, rancid if possible, since this will help to disguise the human smell, and help to allay the suspicions of the rat.

The following recipes will be found useful:—

(*a*)	Barium Carb.: (commercial)	5 parts by weight.
	Flour	2 parts by weight.
	Cheese	10 parts by weight.
	Glycerine	3 parts by weight.

Thoroughly mix and then make into a stiff dough, roll out on a pastry board and cut into squares, making 1,400 tablets for each 1 lb. of Bar.: Carb.: used. Bake lightly and sprinkle with flour flavoured with aniseed.

(*b*)	Barium Carb.:	1 part.
	Flour	3 parts.
(*c*)	Barium Carb.:	6 oz.
	Meal (any corn meal will do)	16 oz.
	Dripping	4 oz.
	Salt	½ oz.

Mix thoroughly. This quantity should give about 1,000 baits, about the size of a hazel nut. Sufficient oil of aniseed or coconut oil should be used to give the necessary odour.

(2) Red Squill Powder.—This is harmless in the quantities used, to most animals—rats excepted. The chief objection to squill is that it has no uniform toxic standard, so that the commercial product is apt to vary in its efficiency. It is important therefore that the purchaser should secure from the manufacturer or his agent, a guarantee as to the efficacy of that particular product.

In preparing red squill baits, however, with commercial red squill powder it is fairly safe to mix thoroughly 1 part by weight of squill powder to 10 parts by weight of any cereal meal, or peanut meal. Further, squill powder has the advantage of being effective in a dry mixture, and in such a case should keep in good condition for a considerable time.

(*a*) Red squill powder, 1 part by weight; flour, 4 parts by weight. Mix into a stiff dough with water; roll out and cut into biscuits, making 700 biscuits for each ½ lb. of squill powder used. This gives about 5 grs. to each biscuit. This form of bait keeps good a long time.

(*b*) Red squill powder, 2 parts; finely chopped bacon, 3 parts; meal enough to make into a coherent mass, then bake in small cakes.

(*c*) Red squill powder can be dusted on fruit, for example, 1 oz. will be enough to sprinkle 3 bananas sliced into 48 pieces, that is 16 pieces to each banana.

Other poison baits, such as arsenical compounds, strychnine, phosphorous, &c., can also be used, but these are very deadly to stock and human beings.

Laying of Baits.—Before poisoned baits are laid, it is advisable to use non-poisoned baits for the first 3 or 4 nights, to get the rats accustomed to the new diet, and then lay the poisoned baits, using an excess number of baits to secure the greatest kill. A fortnight at least should elapse before using baits a second time in one place. Baits should be laid in the evening, and those remaining should be gathered up next morning. In this way a record is obtained of possible casualties, and reliable knowledge gained of the effectiveness of any one kind of bait.

Procedure.—For the plantation, as well as the town, there is only one successful way of tackling the rat pest, and that is by continuous consistent effort on a co-operative basis. Obviously the individual planter cannot meet with success, single handed, except perhaps in the application of the Rodier method. In England and on the continent of Europe, societies or clubs exist for the destruction of these vermin. Such a scheme could be applied here through the various Progress Associations that exist in these islands.

To summarise, there are four main methods of control:—(1) natural enemies, (2) trapping, (3) virus, (4) poison baits.

No one method is perfect, so that a combination of methods is essential. To ensure that these methods have their quota of success, co-operation between the people of any island or district is essential, otherwise the individual who is endeavouring to rid his place of the pest is continually being reinfected from his neighbours' premises. Whatever measures are adopted must be applied continuously and consistently until the pest has been exterminated.

In all cases it is advisable to prebait for a few nights, and then apply the traps and/or baits to secure as large a bag as possible. Allow intervals of about a fortnight to elapse before repeating the attack. Finally, keep a record of all casualties as suggested by the number of baits taken, so that definite knowledge may be obtained of the effectiveness of the system in operation for the expenditure involved.

Amongst the various publications dealing with the rat pest, the book *The Rat—A World Menace*, by Mr. Moore Hogarth, published by John Bale, Sons, and Danielsson, Ltd. London, price 7s. 6d., will be found useful to those interested in the destruction of vermin.

SPECIMENS FOR IDENTIFICATION.

By H. R. SURRIDGE, A.R.C.Sc.(I)., Government Agronomist.

ONE important function of the Department of Agriculture in a Colony such as Fiji is the identification of various botanical and zoological specimens, which from time to time are sent in by various interested people, the interest being aroused mainly through the specimen causing damage to their crops, live stock, buildings, &c., In view of the increasing number of such specimens received in Suva, and the importance of making as rapid an indentification as possible, it is not out of place to publish a few simple directions as to how to collect, prepare and forward such material to the Department of Agriculture.

(1) BOTANICAL SPECIMENS.

Collection.—The great aim to be kept in view in collecting is to obtain as perfect and comprehensive a specimen as possible; that is one showing every part of the plant, root, leaves, flowers, and fruit. It is not always possible to show all these details on the one specimen, in which case several would be required to cover these essential features.

Where it is not practical, from its size, to collect the whole plant, the leaves from the root, stem or lateral branches should be taken, and the flowers collected. It is necessary to ensure that all types of flowers from the one plant, shrub, or tree are forwarded, owing, as in the case of the coconut, to two different types of flowers—male and female—being carried on the same tree, or as in other cases, on different trees.

Specimens should be forwarded in duplicate, if possible in triplicate, since it is sometimes necessary to send specimens away for identification, in which case, one can be retained here for future reference. All possible information should be given as to where the plant is found, the type of soil favoured, whether it grows in the wet or dry zone, the season of flowering, whether annual, biennial, or perennial, or other peculiarities or points of interest noted; in short, the plant's history as known to the collector.

Preparation.—Lay the specimen, if possible, between sheets of paper, and when ready for despatch, tie in a parcel stiffening the parcel by backing it with a piece of thin wood or similar material. This will minimise risk of damage in transit.

Diseased Specimens.—When diseased specimens are being forwarded for the purpose of diagnosis, they should be carefully wrapped up, and if of considerable size, wrapped in sacking or similar material so that during transit to Suva no part may be lost, and the plant, leaf, or whatever section is forwarded for examination, may be received as near to its original condition as possible with the diseased parts showing clearly. This will facilitate identification. As a case in point: a coconut leaf was recently received at this office, it had been cut off the tree, carried at least a quarter of a mile through the street, on a man's shoulder, waving in the breeze. On arrival it was thrown down on to the floor of the verandah, and the writer asked to diagnose the injury. Owing to the method of transport and manner of delivery, no insect life was visible, an important omission in this case, because the damage to the leaf suggested the presence of insects, one of which was the dreaded Levuana moth. Had this leaf been carefully taken down, the leaflets tied to the midrib, and the whole carefully despatched to the office, the larvæ or the adult insect would probably have been found and so the cause of the damage attributed to the moth *Agonoxena* would have received confirmation on finding the insect present. Since the damage done by the moth *Agonoxena* can be confused with that caused by the Levuana moth, this example demonstrates that care is essential when forwarding specimens for identification.

(2) ZOOLOGICAL SPECIMENS.

Collection.—In collecting these specimens, particularly the various insects, &c., which damage our crops, every endeavour should be made to capture them alive and in the act of committing the damage complained of. From purely a collector's point of view, it is of interest to know on what an insect feeds, and to work out its life history. From an economic point of view, it is essential to know on what an insect feeds, at what particular stage in its life history it does the most damage, and is the most susceptible to measures of control.

Preparation.—In forwarding such specimens, it is as well to include plenty of foodstuff to last out the journey and allow for a surplus to carry on with on arrival in Suva. When the specimen is small, the usual tobacco tin will be found very useful to send it in, while the larger specimens a wooden box or a cardboard carton would serve. In many cases it is sufficient to secure plenty of food material, and carefully wrap with sacking when forwarding to Suva. In all cases, however, all possible information should be given to facilitate identification.

When forwarding moths, butterfles, beetles, &c., lay them in tissue paper or similar material, to prevent movement during transit and to ensure reasonable condition on arrival. Here again the tobacco tin, match box or other receptacle, according to size, is of service.

It is essential that all receptacles used for sending insects to Suva should be absolutely ant-proof, or else that some deterrent, such as carbolic acid, should be enclosed with the specimens. Napthalene is useless for this purpose.

All specimens, botanical or zoological, should be addressed to the Director of Agriculture, Suva, and marked "Specimens Urgent."

THE FRUIT FLY.*

It is greatly to be deplored that the Mediterranean fruit fly should have recently made its appearance within the borders of the United States of America—an invasion that again brings to the fore the very important questions relating to the introduction of new pests into countries, and to the efficiency of the methods of preventive inspection and quarantine legislation at present in vogue and which concern nearly all the agricultural departments in the world. The rapidity with which the fly has spread from its supposed original home—the Mediterranean countries, the havoc which it has caused on its trail through Bermuda, Hawaii and the Azores, where it has destroyed important fruit industries, the difficulties which it has given to fruit growers in Spain, Italy, South Africa and Australia, all have been sufficient warnings to Americans of the very great dangers fraught with this pest, and of the necessity of keeping it out of their own country. And yet, their very laudable efforts in setting up elaborate and costly machinery to prevent such an invasion have signally failed and it is now feared that if this fly is not exterminated it will spread in the southern states and become a serious menace to the great fruitgrowing districts throughout the warmer regions from the Atlantic to the Pacific coast. Such a state of affairs leads us to discuss briefly some views on the fly itself and of the ways and means by which noxious insects can be spread and be prevented from spreading.

The Mediterranean fruit fly which is undoubtedly one of the most dreaded and destructive fruit pests in the world, was first recorded in American regions when it invaded the Bermuda Islands shortly after the middle of the last century, and again about 1910, in the Hawaiian Islands. Fortunately for the West Indies and Central America, it has not yet, to our knowledge, found its way there, although it is now distributed throughout the tropical and sub-tropical parts of the world. Its foods include a wide range of fruits and vegetables and the damage is caused by the maggots

* From *Tropical Agriculture*, Sept., 1929.

which hatch and feed within the ripening fruit, thus spoiling it for the market and often rendering it totally unfit for human consumption. When it became known in April last that the fly had been discovered and identified in Florida, the United States Government and the Government of the State of Florida immediately put forward a most energetic campaign. Funds were provided by the Governor of the State and the President of the Nation, and inspection and clearing up services started in an attempt to eradicate the pest before it should spread beyond the limits of the 80 square miles which were at first found to be infested.

It is from about 1910 that the United States Government has maintained a quarantine inspection service at all ports of entry and frontier points. Fruit flies, the Mediterranean and others, and several species of insects, as well as diseased plant material are intercepted in commercial cargoes, in passengers' luggage, and even in their pockets. Reference to quarantine reports will show that thousands of interceptions are made each year, and whilst many of these are well known pests and diseases, others are insects and fungi which might become of economic importance. Although the American preventive inspection and quarantine service has been remarkably efficient it has not always, unfortunately, proved absolutely infallible. Before it was established, the country had been invaded by the Mexican cotton boll weevil, the San José scale, the Gipsy Moth and other pests of primary importance, but even since the existence of this service, pests which may prove of equal importance have found their way in and amongst these must be mentioned the pink bollworm, the Japanese beetle and the European corn borer. The European corn borer is already invading the great corn belt, the Japanese beetle is thoroughly established in certain eastern localities while in the case of the pink bollworm of cotton, hope is still expressed that the pest may be exterminated.

There are very few countries now which do not harbour some important pest which has been introduced through the ordinary channels of commerce and although routine methods of transmission in cargo or passengers' luggage are well understood, and can be reasonably controlled it is not so easy to guard against unforseen methods of ingression. The introduction of insect pests has often been shown to be due either to the carelessness of those who should have been better informed or to complete ignorance, as some of the following examples will show. A few years ago, at the San Franciso Exhibition, samples of cotton from China were shown which were found to be infested with the pink bollworm and indeed proved to be the first record of the occurrence of this insect in that part of the world. In California a law prohibiting the importation of live insects into the State was unintentionally violated by somebody sending a parcel from Kansas containing living grasshoppers which were to be used in trick photography. The collection of souvenirs consisting of twigs and fruits is another way by which pests are scattered and this method is often in evidence in the small West Indian Islands, where tourists take cotton bolls, fruits, pods or leafy twigs in one place only to discard them the next day in a shrivelled condition in another colony. It is not known how the Mediterranean fruit fly entered the United States, but it is probable that something unforeseen gave the insect its chance to establish itself.

The Mexican fruit fly or Orange worm is another pest against which an intensive quarantine inspection has been maintained. This insect, also, got past the quarantine barrier early in 1927 and has caused a short war of extermination on a restricted area in Texas. This seems to have been

successful for although the insect is commonly to be seen in the market of Matamoros in Mexico, it has not been recorded on the Texan side of the Rio Grande for about two years.

The greatest danger in the distribution of crop pests and diseases undoubtedly lies in the rapid growth of modern transport facilities which bring with them an increasing number of cargoes and passengers—both potential sources of infection. To this must be added the fact that the balance of nature has been considerably disturbed through the opening and planting up of virgin areas which are fresh ground for the successful development of certain insects. With the help of trade the latter have in turn been exported from their native haunts to new localities, where, no longer under the control of their natural enemies they have done irreparable damage. In fact, the further the problem is studied the more complicated it becomes and the more difficult it will be to find successful means of controlling known pests. The war with insects which began with civilization can never cease and in future only partial control can be hoped for. At present such control consists of the use of poisons, the encouragement of natural enemies, the development of immune or resistant strains of plants and an understanding of the relation of plants in good health to immunity from attacks from certain types of insects. All, although they are not absolute means of control, have their value, but often some trivial and entirely unsuspected circumstances may give an opportunity for invasion, even with the best inspection service. As civilization further progresses the problems to be tackled by entomologists will become more and more intricate but this should not deter the layman from doing his share by studying when he can those pests which may well become a very great danger to the community of which he is a member.

FRUIT FLY CONTROL.

Among the fruit flies, the chief offender in Fiji is *Dacus passiflorœ*. Although Fiji is specially suited for biological methods of control I do not recommend them in this case. Chemical methods (spraying and poison baits) are practicable, but would require very careful organisation on a large scale if they are ever to be effective.

The greatest difficulty is the abundance throughout Fiji of guavas and other native fruits in which the fruit flies breed, and unless these were tackled at the same time as cultivated areas, very little good would result. At the present time, the growing of citrus fruits in Fiji is a very casual haphasard business, and in such circumstances control measures are not worth while. Even if they were begun in a proper manner they would not be maintained with sufficient regularity to be effective.

If, however, extensive cultivation of citrus fruits is contemplated, a campaign against fruit flies would be well worth while. It would be possible and practicable to reduce the quantity of fruit flies very greatly by chemical means if the areas under citrus were large and well cared for. In such circumstances I would recommend the use of poisoned baits (rather than spraying) in conjunction with the destruction of all wild fruit trees in the neighbourhood.

BALED COPRA.*

By C. D. V. GEORGI, Acting Agricultural Chemist, and F. C. COOKE, Assistant Chemist for Copra Investigations.

INTRODUCTION.

THE usual method of packing copra is to suspend an open sack from the roof of the copra store and to compress the contents by means of heavy poles used as rams. By this method two coolies can fill ten bags, each containing a picul of copra in one hour. For shipment to Europe, new bags costing 50 cents each are frequently employed, having a capacity of between 133 lb and 2 cwt., while second-hand bags are almost invariably used for the local sale of copra.

THE PROPOSAL TO BALE COPRA

It has been suggested that the effective space, occupied on ships and in godowns by a ton of copra, can be reduced, and pilferage controlled by packing well-dried, good quality copra in the form of compressed, oblong blocks of uniform size and shape, and weighing two cwt. each. Such bales can be handled, stacked and checked easily and well, and, provided that the moisture content of the material was less than 7 per cent. resistance to mould growth, to the development of acid and rancidity and to insect attack would possibly be greater than when copra is packed in sacks.

DESCRIPTION OF PLANT AND PROGRESS.

As is the usual practice with " mixed " copra for export, the copra is first sorted to remove bad pieces of " F.M." (fair-merchantable) quality. The good copra of F.M.S. (fair-merchantable, sun dried) quality is chopped by women to give eight pieces per nut. This sizing, which assists compression of the bale and encures a cohesive block, could alternatively be done in a turnip cutter.

The practice of chopping after drying is already practised on some estates, end serves to ensure a product of uniform and convenient size; to improve the appearance of the copra; to prevent the accidental inclusion of dirt, foraign matter and pieces of second quality copra; to assist further drying; and also to ensure that the copra makes a close and tight pack. On the other hand it might be better to chop the copra in the half dried condition, when it is being removed from the shell; if this is done, the cut surfaces will seal up in later stages of drying and the rate of drying will be durther accelerated and more uniform drying assured.

The following is a description of a baling press which is in operation in Selangor:—

The baling machine consists essentially of a long steel box 4 feet high, with two fixed sides and two hinged sides, and capable of being swung as a whole on a vertical shaft. All the sides are reinforced by strengthening girders, and secured in position by a rapid acting clamping device. The top and bottom of this box consists of two removable, grooved, wooden plates or " platens," strengthened and backed with steel, and making a close, sliding fit with the vertical sides. These " platens " are removed from the machine, and two new pieces of Hessian cloth (40 ft. by 48 in. which will

* Extract from *The Malayan Agricultural Journal*, Vol. XVIII, No. 6, June, 1930.

ultimately cover the bale are laid over them, and secured in position. The top " platen " is then fitted to the underside of a stout cross-arm, supported on two vertical joists immediately over the hydraulic ram-head; and the bottom plate is placed in position in a recess at the bottom of the box which is thereupon closed securely by the clamps.

The power to work the hydraulic ram is obtained from a 10 h.p. Tangye engine through a counter shaft, the pressure being applied and controlled by a simple arrangement of levers.

Two cwt. of the chopped copra are emptied into the box and levelled up. The filled box is then swung smoothly into position over the ram head and immediately under the top " platen " suspended from the cross-arm. A pressure of 28 tons is slowly applied, until the copra ceases to compress, through the ram-head to the underside of the lower " platen," the area of which is 384 square inches. The effective pressure on the copra during a compression period lasting 40 seconds, is thus 1·5 cwt. per square inch.

When the limit of compression at this pressure has been reached, the ram is locked in this top position, and the clamps securing the box quickly released. The whole cage then swings clear of the bale, back to its original position where it is recharged. The bale remains held in position between the two " platens " by the locked ram-head, and the copra is thus exposed to view, a solid oblong block, with not a trace of oil exuding from it. The Hessian cloths are loosened from the " platens " and roughly " stabbed " into position over the block of copra. Three " safe-seal " wires are next passed through the grooves in the " platens " so as to encircle the bale and they are separately tightened and sealed by a portable " Griplock " sealing machine. The ram is now released, and the bale trucked away for sewing.

WORKING DETAILS.

	Baling process.	Bagging process.
Maximum throughput of process	17 bales per hour or 34 cwt. per hour.	10 bags per hour or 12 cwt. per hour.
Time for one complete bale or bag	6 minutes	6 minutes.
Weight of packing	4 lb to 2 cwt. of copra	2 lb to 1 picul of copra (equivalent to 4 lb to 2¼ cwt.).
Cost of packing materials ..	45 cents a bale or 23 cents a cwt.	50 cents a bag or 38 cents a cwt.
Pressure applied at ram	=28 tons.	....
Pressure on the bale	=1·5 cwt. per square inch.	....

It is not possible to give details of the labour requirements until the present plant is on a full-time regular production.

THE BALE.

The finished bale is a very neat oblong block of a convenient size and shape to handle. Four pieces of split bamboo which are inserted with the Hessian cloth under the wires, serve to keep the bale rigid and compact, and prevent the wire cutting into the copra and so loosening during the vibrations of transport.

The volume occupied by the two cwt. of baled copra is under 5·3 cubic feet, as against 8·3 cubic feet for the same weight of copra in sacks and the overall dimensions of the bale are 25¼ in. by 17 in. by 21 in. The bales pack very neatly and squarely; 84 bales arranged in a stack, 7 high, 4 wide, and 3 deep, occupy 49 cubic feet (12 ft. 7 in. by 9 ft. 3 in. by 4 ft. 2 in.). Thus the " broken stowage " for 100 bales (10 tons 4 cwt. in weight with packing)

will be 58 cubic feet. At present, because it is a bulky commodity, 12 cwt. of bagged copra are charged freight, as though they weighed a ton, whereas if the copra were baled, a ton of copra could be freighted as such without correction, and 8 cwt. stowage could be saved.

POSSIBLE OIL LOSS DURING BALING AND SHIPMENT.

(*a*) *By compression.*—Although the pressure is gradually applied to the loose copra and is only of 40 seconds duration, it might be thought that oil would be lost. There is, however, no sign of loss of oil, nor darkening of the floor immediately underneath the press, and if the hand is rubbed over the exposed block of compressed copra, it will be found to show no trace of exuded oil.

The bale of copra is wired and left in compression, so that the pressure is maintained, until the block is broken up. It could be argued, therefore, that the vibrations and shocks of transport might cause oil to exude and be absorbed in the Hessian covering material. There is, however, no loss of oil on this account.

(*b*) *By self-heating.*—In a single bale of copra, the facilities for heat escape may be worse than from the centre of a bag of loose copra. It is almost certain however that a stack of bales is better ventilated than a stack of bags because of the straight channels and connected air gaps which must separate each bale and allow free passage of the cooling air. In a heap of bags, the air spaces which exist inside are generally sealed at some point by the weight of superimposed copra.

When copra deteriorates, heat is liberated and, under the conditions existing in a stack of sacks in the hold of a ship, is accumulated to the further detriment of the copra and the production of free acidity, moisture, colour and rancidity with loss of oil.

It will be seen, later, that in the trial shipment of good baked copra, no oil loss whatsoever has occurred, and that the free acid formation is somewhat less than the average for sacked Malayan copra of good quality.

CONTROL ANALYSIS OF A TRIAL SHIPMENT OF COPRA.

A small quantity of copra was taken from each bagful of a large consignment of copra, prior to baling. This total sample weighing about 360 lb was then well mixed, spread evenly on the floor, and the pile divided into four quarters. The copra from two diagonally opposite quarters was taken for pressing into a sample control bale, to be kept in the store shed of the Department of Agriculture, and the copra of the remaining two quarters was then "quartered down" until only 10 lb was left. From this small amount, three samples were drawn for determination of the percentages of moisture and oil in the copra, and of the acidity of the cold expressed oil. The loose copra still remaining was then placed in a sack and stored under the same conditions as the control bale. The results of the analysis, and the appearance of the copra indicate that the copra was of normal good F.M.S. quality.

ANALYSIS PRIOR TO DESPATCH.

Test.	Sample. No. 1.	Sample. No. 2.	Sample. No. 3.	Average.
Moisture per cent.	6·8	6·7	6·7	6·8
Oil per cent. (wet basis, copra as received)	60·1	60·9	60·6	60·6
Oil per cent. (dry basis)	64·6	65·3	65·0	65·0
Acidity per cent. (as lauric acid) ..	·65	·74	..	·70

The main consignment of bales was despatched to Europe and two months later the control bale and sack of copra stored at the Department of Agriculture were re-weighed and tested with the following results:—

ANALYSIS AFTER TWO MONTHS.

Loss in Weight.

Pack.	Nett weight, June 25th.	Nett weight, August 27th.	Per cent. loss in weight.
Bale	229 lb	224 lb	2·2
Sack	113 lb	111½ lb	1·3

Acidity of the Cold Expressed Oil (as Lauric Acid).

Sample taken from	Date.	Acidity per cent.
Loose copra before baling	June 27	.. ·70
Copra from centre of bale		1·72—Aver. 1·44
Copra from outside of bale	Aug. 25	1·16—
Copra from sack	Aug. 27	.. 1·43

There was little evidence in either case of mould growth, although in both cases the copra had been attacked by a variety of insects. The stored bale showed no signs of oil exudation, nor were there any indications of the copra becoming self-heated by deterioration in the absence of freely moving cooling air within the bale.

The main consignment of this copra, despatched to Europe in baled form, arrived at its destination in August, where it was analysed both by the consignees (*c*) and also by an independent arbitator (*a*).

COMPARATIVE RECORD OF ANALYSIS.

Total Oil Content before and after shipment.

		Weight. Cwt.	Oil per cent. (Wet basis).	Total oil. Cwt.
Loose copra before baling		1,904¾	60·6	1,152
The same copra as received in baled form in Europe	(C)	1,845¾	62·8	1,158
	(A)	1,845¾	64·0	1,180

Quality.

Sample taken from		Moisture per cent.	Oil per cent. (Dry basis).	Acidity per cent.
Loose copra before baling . ..		6·8	65·0	·70
Stored in Malaya (baled) . ..		..	..	1·44
(sacked) . ..		..	..	1·43
Baled copra as delivered ..	(C)	4·5	65·8	1·51
	(A)	4·6	67·2	1·48

Per cent. Loss in Weight in two Months.

Circumstances.	Loss in weight. per cent.
During storage in Malaya—as a single bale	2·1
Do. as a single sack..	1·3
During shipment to Europe in baled form	3·0

From the above it will be seen that the copra does not lose oil during baling or subsequently during shipment and storage. The slight differences in the calculated amount of total oil are within the limits of experimental error if consideration is allowed for possible differences of method, and for personal error.

The acidity of the oil was determined here on the cold expressed oil and not on the oil extracted by solvents, the latter giving slightly lower results. It would appear that, in spite of the cooler conditions on the way to Europe, the stacked bales deteriorated slightly more than the solitary control bale kept at the Department of Agriculture, whilst the loss in weight was also greater, though of course the conditions of storage were very dissimilar.

THE DETERIORATION OF STRAITS F.M.S. COPRA DURING SHIPMENT IN SACKS TO EUROPE.

Eighteen large samples of F.M.S. copra from various estates in Malaya gave the following results on analysis:—

Moisture per cent.			Oil per cent. (dry basis).			Acidity per cent.		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
6·9	9·1	4·7	65·9	69·0	62·2	·18	1·00	·03

Seventeen different bulk consignments of Straits F.M.S. copra, received in Europe in sacks, yielded the following figures from the analysis of the consignees:—

Moisture per cent.			Oil per cent. (dry basis).			Acidity per cent.		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
4·7	5·5	3·9	65·0	67·0	63·6	2·25	5·06	·35

It will be seen that the average acidity has increased from ·18 per cent. to 2·25 per cent. for copra in sacks, whereas the trial shipment of baled copra only increased in acidity from ·7 per cent. to 1·5 per cent. The loss of moisture for copra in bales and in sacks, is however, identical.

CONCLUSIONS.

1. There is no indication of loss of oil during or after baling when the copra is properly dried, is of genuine F.M.S. quality and is packed cold.

2. There is no evidence that the copra deteriorates more when in the form of compressed blocks, than it does when stored in sacks, in fact there are indications to the contrary.

3. The system of chopping before baling will ensure product of uniform and convenient size which will be easy to handle by the crushers, and will also prevent the accidental inclusion of dirt and foreign matter by the producer.

4. Baled copra is convenient for handling, stacking and checking.

5. The trial shipment arrived in Europe " intact and in good order."

6. The effective space occupied by copra in baled form is one-third less than when stacked in sacks.

7. In conclusion, the writers wish to record their thanks to Mr. F. W. Douglas for technical assistance in this inquiry; also to Mr. Gunn Lay Teik for carrying out the analytical work.

The dollars quoted in this article are Straits Settlements currency $1=100 cents=2s. 4d. Also 1 picul=100 katis=113⅓ lb.

For explanation of the significance of oil per cent. (wet basis) and oil per cent. (dry basis) see *Malayan Agricultural Journal*, Vol. XVII, Sept., 1929, No. 9.

MAIZE.

AUCKLAND merchants object to Fijian maize because of the presence of weevil in practically all consignments. This fault could be removed by fumigation, which is an expensive process, that could, however, be economically carried out prior to shipment. The only method of satisfactorily drying maize artificially is by dehydration, which shrinks the grain to such and extent that it is almost useless after treatment.

The present duty in New Zealand is 2s. per 100 lb plus 22½ per cent., with no primage; that is to say 2s. 6d. per cental.

April, May and June are the best months to ship maize from Fiji in order to reach the market before maize from South Africa arrives, which is generally about the end of June. Prices are usually steady during these months. The values during 1930 were from 6s. 6d. to 6s. 9d. a bushel. A good market exists in New Zealand for Fijian maize provided that the weevil can be eliminated before shipment and the grain is thoroughly dry and hardened.

(*Note.*—Duty of 2s. 6d. per cental is equivalent to 1s. 4½d. per bushel. Freight costs 55s. per ton, wharfage 1s. 10½d per ton, making total charges f.o.b. Suva to c.i.f. Auckland 2s. 9½d. per bushel, cartage extra).

Unless Fijian maize can be landed in New Zealand at very cheap rates it would be useless to export during the months of July to December. From December to July African and Java maize is imported in large quantities into New Zealand but only at such times when the locally grown maize is in short supply or is being sold at prohibitive prices. In New Zealand, African and Java maize is quoted c.i.f. at 160s. to 195s. equivalent to 4s. to 4s. 11d. per bushel. On August 6th, 1930, quotation for African importation, shipment *via* Australia was 151s. per ton c.i.f. & e., New Zealand ports.

One firm states that experience shows that a small, round, hard yellow maize sells better than the large horse-tooth variety. The maize trade in Auckland is amongst poultry keepers only who dislike large grain for feeding purposes. Small immature grain must always be excluded and good packing in clean once-used sacks, well sewn and branded, not exceeding 200 lb per sack nett will improve the selling value of the maize. The custom is to sell in 400 to 500 tons parcels.

In the earlier days of maize growing in the Bay of Plenty it was considered that shelling of the cobs should follow their storage for six to ten weeks in the crib, and it was seldom that a much longer period was allowed to elapse on most of the farms where the crop was grown. Consequently storage provision was often of a temporary nature, and as the practice of holding the crop for longer periods developed this storage was often quite inadequate, especially where crops were held for as long as twelve months.

Of the cribs built the most satisfactory for the smaller growers was the tapering (from top to base) form. Such a crib was usually 8 ft. to the eaves 5 ft. wide at the base, 7 ft. wide at the eaves, and varied in length, according to requirements, from 12 ft. to 25 ft. As the tapering sides were subjected to severe strains when the crib was filled it was found necessary to provide wall supports in the structure, spaced at 3 ft. to 4 ft. intervals along each side. With the shorter cribs a door at one end was sufficient for convenience of filling, but where the length approached or exceeded 20 ft. it was found desirable to have a door at each end. In some cases landing-stages were built for convenience in filling, but it was found desirable that these should be movable so that they could be dispensed with at shelling.

A modification of this type of crib has arisen through a desire to reduce expenditure. The sides in this case are vertical, being constructed of spalings spaced at 4 ft. intervals with longitudinal battens to support the wire netting which is used to line the crib. The roof is of the lean-to type. This is perhaps the least desirable of all types when storage is required for long periods, as losses due to birds, mice, &c., are considerable; but where shelling follows harvesting within a short storage period, or where maize-growing is not a regular practice on the farm, it provided the grower with a cheap means of storing the crop.

On the larger maize areas, where considerable space is required, it is often the practice to build two long cribs—up to 40 ft. each in length and parallel to one another—under the one gable roof, with sufficient space between them to provide accommodation for the various farm implements. Doors for filling are usually provided at each end, with sliding-doors situated midway down the inner sides of the cribs to provide means for feeding cobs to the sheller, which is usually brought into the implement space to allow of shelling from both cribs without having to move the machine. These cribs which have vertical walls, are usually 6 ft. wide, 8 ft. to 9 ft. high, and from 20 ft. to 40 ft. in length. In addition to housing implements the space between the cribs promotes air-currents, which materially assist in the drying of the grain. Arising out of the foregoing type there has also been evolved a single crib similar in all respects to each section of the double crib just described.

It is claimed for this type of crib that owing to the vertical walls there is far less strain on the walls than in the case of the type with tapering sides, and consequently there is no necessity to strengthen the sides with wall supports. Furthermore, greater capacity is claimed without increase in expenditure on timber. A somewhat greater overhang of the roof is necessary, however, to protect the cobs efficiently from the weather. Various other modifications are occasionally encountered, chief of which perhaps is the single crib built on to the back of an implement-shed; but the great majority conform to one or other of the foregoing types.

RECOMMENDED DESIGNS.

With the object of providing information on the construction and cost of cribs embodying the most desirable features, drawings, specifications and estimates were recently prepared by the Agriculture and Public Works Departments for the guidance of growers. Two designs were adopted. A combined double crib and implement-shed, for areas up to 18 acres where the crops average about 50 bushels per acre and a single crib embodying the features of one storage section of the double type, for areas of six to seven acres at a similar crop average.

In explanation of the dimensions given for the cribs it should be understood that heights and widths as specified have been arrived at as the most suitable for promoting best drying conditions. Growers with considerable experience regard 6 ft. to 7 ft. as the greatest width that should be employed in any crib. In regard to height there is a greater range of opinion; but even in this respect few successful growers favour heights exceeding 10 ft; generally 8 ft. is regarded as the most suitable. The length of crib can be varied between wide limits, and will depend to a great extent on the quantity of maize to be stored.

SITE AND POINTS IN CONSTRUCTION.

Realising that the chief point in storing maize cobs in a crib is to provide sufficient aeration to allow the grain to fully mature, it will be at once apparent that choice of site for the crib is of some importance. Air-currents play a greater part in efficiently drying out the grain than does warmth direct from the sun. Consequently, where it can be conveniently arranged, a site near or under a belt of tall trees would be preferred to one in the open, as direct sunlight on the grain bleaches it, thereby making it less attractive when marketed. On no account, however, should a crib be built where the soil is unduly damp, as the moisture in rising has a deteriorating effect on the grain.

It is desirable to have the floor at least 2½ ft. from the ground, so as to allow air to freely circulate beneath as well as around the crib. Rising soil moisture can then escape without in some measure passing into the lower layers of cobs. The flooring itself will be more effective in promoting drying if the boards are spaced so as to allow ½ in. to 1 in. spaces between them. There will be perhaps a slight loss of grain between the boards but this is comparatively insignificant compared with the benefit derived from the improved aeration of the lower portion of the crib.

Walls and ends should always be timbered vertically with 3 in. by 1 in. battens spaced 1 in. to 1½ in. apart to allow of aeration. In addition it is desirable, althought perhaps not essential, to have the crib lined with bird netting so as to reduce losses of grain. A gable roof is much more satisfactory than one of the lean-to type as it is easier to provide adequate overhang with this type for protecting the cobs from the weather.

Tin shields are occasionally employed on the blocks in an endeavour to keep out rats and mice, but, owing to the fact that most cribs are not more than 2 ft. to 3 ft. above ground-level, it is doubtful whether their general use could be advocated. Rats in particular would have little difficulty in jumping from ground-level, but fortunately they are not a serious pest in most cribs in the maize-growing areas.

MAIZE.

By H. R. SURRIDGE, A.R.C.Sc. (I.), Agronomist.

THE evidence of history is that maize originated from America. Since the discovery of that country in the fifteenth century, the cultivation of maize has extended throughout the world so that it now holds a leading place with wheat and rice as a staple food crop. The following figures extracted from the *International Year Book of Agricultural Statistics*, 1928–1929, show the important position that maize holds amongst the world's cereal crops:—

Wheat, 1,225,223,000 quintals; Maize, 1,079,119,000 quintals; Rice, 880,163,000; Oats, 731,625,000; Rye, 437,592,000; Barley, 403,964,000. (quintal=100lb).

In Fiji maize has been grown for many years. Seemann in his *Flora Vitiensis*, states that at the time of his visit (1865–1873), "only one kind of corn—a small yellow grained one—was cultivated by the white settlers, the native not having as yet, taken to growing it." Since Seemann's time, with the continued settlement of the country by Europeans and subsequently Indians, the cultivation of maize has extended so that in recent years there has usually been an exportable surplus, varying within wide limits, as shewn by the following figures extracted from the Fiji Blue Books:—

1920, 42,732 bushels; 1921, 62 bushels; 1922, 1,030 bushels; 1923, nil; 1924, 210 bushels; 1925, 2,048 bushels; 1926, 1,513 bushels; 1927, 2,560 bushels; 1928, 3½ bushels,; 1929, 4 bushels.

These fluctuations would appear to be due more to poor quality with the consequent low prices than to prevailing low prices for maize of standard quality.

As a food crop for human consumption it has not yet attained, in these islands, the place it deserves, its present uses being mainly confined to stock and poultry. The crop is a simple one to grow, the plant being adaptable to a wide range of conditions as regards climates and soils, demanding

of the grower a deep preparatory cultivation and subsequent clean land. As might be expected, the cultivation of this crop reaches its highest development in America where its importance as a crop exceeds that of wheat.

Species and Varieties.—The different species show variations in such points as time required for maturing, height of plant, size of leaves, position of the ear or cob on the stalk, the number of ears, the size and shape of the cob, the number of rows of seed, their regularity or otherwise, and the size, shape colour &c., of the grain. These variations are due primarily to the ease with which maize is cross fertilised, so that it is worth noting that the choice of a variety is of much less importance than the improvement of that variety when once chosen.

Selection of Seed.—The fundamental principle behind what is termed "Mendel's Law of inheritance" is that "like begets like." In selecting seed for planting, therefore, particular attention should be paid to the type of seed demanded by the market in which seed the will be sold. In New Zealand a smaller grain is preferred, since most of the maize required is for poultry.

The feeding value of the grain depends upon its construction. The white starchy part contains less protein, that is flesh forming material, than the horny starchy part and is therefore less valuable. The germ, though rich in proteins is chiefly valuable for the oil it contains, so that to secure a grain of high feeding value it is necessary to select the grain with the largest germ and the smallest starch content. Further, the process of selection must extend to the cob by selecting those cobs of the greatest uniformity, with seeds as already described, set in regular rows and tightly packed. The seeds at both ends of all cobs should be discarded since their progeny will not give the desired result. The nearer the cob is, in shape, to the perfect cyclinder, the higher the possible yield.

In maize, colour appears to answer the purpose of identification only; no one colour appearing superior to another. There are three general colours, white, yellow, and red. White is always white and readily distinguishable. Yellow ranges from a pale lemon to orange presenting difficulty in identification only when approaching the border line between orange and red. The reds usually separate out into light reds with a white cap and dark reds without the white cap. In selecting corn, therefore, select cobs of uniform shape, size and colour, discarding all ears which appear diseased, discoloured, irregular in shape, and with rows not straight The longest ears are required together with seed having the largest proportion of germ to starch.

To Produce good Seed.—For those who wish to improve their maize the following is probably the best method to secure the desired result in the shortest time. The method is known as the "ear to row" method, and consists of selecting the best cobs that conform to the required standard, discarding the seeds at the base and tip, using the remainder for sowing. A good cob should give from 400–600 seeds, so that the length of the planted rows will be controlled by the cob with the least number of seeds.

Mark out the rows and sow the seeds of one cob to one row, until all the cobs have been disposed of. The surplus grain, that is the grain over and above that required for the rows, can be mixed and sown in the usual way. It is necessary, however, to isolate these seed rows from the general crop, if possible, by growing another tall crop betwixt the two. The reason for this, as already given, is that maize is cross fertilised so easily.

On the seed crop maturing, the procedure of selection has again to be repeated. In the course of a few seasons it will be found that a very uniform crop can be grown giving a higher return per acre, which will more than compensate for the care and attention given to selection.

Soil.—To secure the best results with maize, good soil containing plenty of humus is required, a condition which obtains most on the alluvial flats and small areas of " bila " land found throughout these islands. A medium to heavy loam is preferable.

Preparation of Soil.—Maize requires deep cultivation, the success of the crop depending probably more on the preparation before sowing than perhaps any other factor. A good deep ploughing, followed by a thorough harrowing to work the land up to a fine tilth is required. Wherever possible, all humus, *i.e.*, dead leaves, stalks &c., should be ploughed in, to maintain the fertility of the soil and improve its physical condition and moisture content.

Planting.—This process can be done by hand or with the aid of a maize drill. The land should be marked out in rows, with the plough, and the seed dropped into the furrow, the furrow being 2 in. or 3 in. deep, at intervals. The distance apart in the rows depends on the method of cultivation following the planting. To drill a field in one direction means cultivating in one direction, therefore single seeds may be sown in the furrow or drill, one foot apart, with the drills four feet apart. If, however, the " check " system is adopted, the field is drilled or lined in two directions, up the field and across the field at right angles, three or four seeds being planted at the intersections of the lines. By this method, subsequent cultivation can be done in two directions by horse or other implements and the land receives a more thorough cleaning and stirring. The distance apart of the lines will depend on the quality of the soil, but 3 ft. to 4 ft. would serve in most places.

In New South Wales the use of a furrow opener in front of the maize drill has been found of service under certain conditions, especially where nut grass is troublesome. The furrow opener consists of a pair of discs set at an angle and close together in front, or a pair of double mould board sweeps which preceed the drill and help to steady the drill in action. Amongst nut grass this method has been found essential.

Season of Planting.—In these islands, maize can be sown at almost any time. That sown, however, at the commencement of the rains would be harvested at the close of the wet season. Such corn will not keep too well and is therefore not good for export. That sown towards the end of the wet season, and harvested during the dry season, will keep better and be more suitable for export. The early sowings are usually attacked by weevils while the later sowings do not suffer so severly.

In considering the New Zealand market, to secure the best prices, maize must be marketed between April and June to catch the market before the South African shipment arrives. If forwarded for sale after June, it must be of the highest quality to compete with the overseas corn then arriving. Therefore, in growing for export, the planting season will be controlled by the final destination of the crop.

Fodder Requirements.—The foregoing directions refer to maize planting for corn production. Amongst the dairy men of these islands maize might be of service as a green fodder, during the dry season when grass nutriment is at its lowest. Maize when sown singly and fairly close together tends

to sucker freely so that a heavy green fodder crop would result from the sowing of single seeds in drills about 3 feet apart. Such maize, however, would not produce a very good quality corn.

Cultivation.—When the plants are one foot high,thin out the weaklings (check planting) leaving one strong plant to each planting hole. This will tend towards maximum yield.

During growth the soil should be worked towards the plants to enable the plant to secure a firm hold on the ground to withstand heavy rains and wind. Shallow cultivation only should be done and continued until the plants are sufficiently high enough to check all weed growth. Several light cultivations are of more benefit than two or three severe cultivations. The necessity is to keep down weeds, maintain a thin soil mulch to allow rain to enter the soil freely and conserve soil moisture.

In New South Wales harrowing is commenced immediately after sowing and continued until the plants are 6 in. or 8 in. high. It is claimed that plants treated this way stand up better against lodging by wind, while the harrowing destroys the weeds and maintains a thin soil mulch.

Manuring the Crop.—Although maize has been grown for a considerable time in these islands no suitable manuring formula has been evolved. Lands that are subject to flooding are usually renovated by that flooding, but where land has not this advantage every effort should be made to return as much as is taken out by the crop. With a crop that is sown for the grain, a heavy drain is made on the fertility of the soil producing that crop, so that every effort should be made to conserve fertility by returning all leaves, stalks, &c. Also experiments should be undertaken with artificial manures to secure the highest return for the money invested.

A useful rotation to work with land given up to maize is to sow Mauritius Bean either alternately or once in every two years. If grown alternately it should be possible to secure a profit from the sale of the bean seed. If, however, the bean is sown once in two years, it would be preferable to plough in the bean crop about flowering time. This would give humus and nitrogen to the soil and succeeding crop with beneficial results.

No system of crop rotation with reference to maize has been worked out for Fiji, but it should be practical to work maize in with a rotation of some leguminous crop, *e.g.*, Mauritius Bean, tobacco, cotton and perhaps potatoes in some districts, with beneficial results to the crops and therefore the producer.

Harvesting.—When the corn stalks have dried, the maize is ready for harvesting. Here in Fiji only the grain is of major importance, so that the cobs are gathered in from the field, husked and spread out to dry. This latter operation is most important for the value of the grain in most outside markets depends upon its dryness; for export it should not exceed 12 per per cent. of moisture. To secure this degree of dryness, very thorough and efficient drying is essential and close attention should be given to the whole operation to secure the minimum moisture requirements of the final market. If the ears are broken from the stalk before the grain is thoroughly dry, considerable shrinkage takes place.

In America and South Africa use is made of the stalk, leaves, husks and shelled cobs for various kinds of stock feeding, the manure results from this feed being returned to the land for the following crop.

Crop.—In most countries 40–60 bushels per acre may be taken as a fair average crop although individual farmers in America and South Africa frequently exceed 100 bushels of shelled corn per acre. In Fiji no reliable

records are available, individual cases of 40 bushels per acre are known and considered very good. From these figures it will be seen that considerable improvement could be made in the growing of the crop here.

Shelling.—This is performed when the whole ear is quite dry and the grains are required for market separated from the cob. Several machines for shelling husked maize are on the market at prices ranging from £2 or £3 to nearly £100. In selecting one the chief point to take into consideration is the amount of corn to be shelled.

Storing.—Maize may be stored with the husk left on or after it has been husked. That with the husk left on suffers less from insect attack during storage. To keep well, maize *must* be throughly dry. Thorough drying of the grain hardens the outer seed coat and tends to reduce the risk of attack from weevils, moulds, &c., at the same time killing eggs and spores that would be present.

Marketing.—All maize should be carefully sorted before marketing, separating all inferior and immature grains particularly, those attacked by moulds or insects, so that the sample offered is sound, clean corn. For the export trade the sample should also be thoroughly dry, *i.e.*, the moisture content should not exceed 12 per cent.

DISEASES AND PESTS.

In Fiji the chief pests of the maize crop appear to be the maize moth and the maize weevil, both attacking the dry grain. Leaf hoppers and aphids are often present on the leaves and leaf stalks but, at present, do not appear to affect the plant or the yield.

The minah is very troublesome amongst young maize in certain localities, the birds rooting up the young seedlings and eating the seed that is still attached to the roots, or, where the seedlings are rather older, breaking the stem of the plant in their endeavours to uproot them. The moth and weevil already referred to, are pests which usually attack the stored grain and therefore concern the large grower and the merchant who has to effect storage pending the sale of the grain.

The maize moth.—These are small greenish-brown moths found in the neighbourhood of stored grain, usually in great numbers, resting during the daytime with the wings close to the sides of the body. In this position the fore-wing shows a dark band across the body about one-third of the way from the base. The hind-wings are pale brown in colour with no particular markings. The wings when expanded measure about three-fifths inches, while the length is about half that. The female moth lays its eggs *on* the husked grain, from which a small larvæ emerges in due course which bores into and destroys the grain, working from one grain to another until fully fed, when it pupates, emerging as an adult moth in 9 or 10 days to repeat the process. This causes considerable damage amongst the stored grain.

Control.—To prevent such damage, the corn should be stored after husking in clean, sound, closely-woven bags. Another method, where practical, is to fumigate the grain to destroy all moths with carbon bisulphide at the rate of 1 lb to every ton of grain or 1,000 cubic feet of bin space. When using this substance, great care must be exercised and all lights extinguished as the poisonous vapour is extremely inflammable.

The grain weevil (*Calandra granaria*).—This is a small brown weevil about one-eighth of an inch in length and, like all weevils, has the typical long snout with which it attacks the grain. Its life history is similar to that of the maize moth, except that in this case the grain is punctured and the egg

is laid *inside*. From this egg a small larva hatches out, feeds in the grain, leaving the outside skin. This is repeated until the larva is fully fed, when it passes through a resting stage to emerge eventually as an adult weevil. The adult weevil also attacks the grain so that the attack is constant and continuous.

Control.—Thorough drying of the grain and good clean, storage go far to reduce the damage caused by this pest. The heating of improperly dried grain during storage establishes favourable conditions for these insects. Fumigation with carbon bisulphide or hydrocyanic acid gas is also a satisfactory method of destroying weevils under certain storage conditions.

GINGER.

INQUIRIES have been received on the subject of the local cultivation of ginger. The matter was referred to the Director of the Imperial Institute, London, whose reply, together with a valuable article on the subject, is published below:—

N. 1173/5. Imperial Institute, South Kensington,
London, S.W.7, 22nd April, 1930.

Sir,

With reference to your letter of the 5th March (No. 341/30) on the subject of ginger, I enclose herewith a cutting of an article on *Ginger—Its Cultivation, Preparation and Trade* from the *Bulletin of the Imperial Institute*, Vol. XXIV (1926), No. 4, which will probably supply much of the information that you require. With regard to possible markets for the product you will note from the section* of the article relative to trade and production (p. 678) that the bulk of the dried ginger produced in Jamaica, India and Sierra Leone is taken by Great Britain and the United States.

There is little to add to the information on methods of cultivation and preparation contained in this article. It may be pointed out, however, that the crop should be prepared in the form of the dried, peeled "root"; the production of preserved ginger such as is shipped from China requires special methods of cultivation and preparation. The market value of peeled ginger depends very largely on the method of preparation and the care with which the process of peeling is carried out. The best Jamaica ginger, for example, is at present realising 71s. to 90s. per cwt. as compared with 45s. per cwt. for the less well-prepared product from West Africa. Twelve months ago, the corresponding figures were 110s. to 120s. and 54s. per cwt. respectively.

Consignments of ginger or other spices could be sold in London through brokers, or possibly direct to merchants. The following firms are interested in spices:—

Brokers—

Messrs. Lewis & Peat Ltd., 6 Mincing Lane, E.C.3.
Messrs. Dalton & Young, 28 Fenchurch Street, E.C.3.
Messrs. Samuel Figgis & Co., 45 Fenchurch Street, E.C. 3.
Messrs. Hale & Son, 10 Fenchurch Street, E.C.4.

* Not published.

Merchants—

Messrs. Joseph Travers & Sons Ltd., 119 Cannon Street, E.C.4
Messrs. Dunlop Bros. & Co., 12 Fenchurch Avenue, E.C., 3.

Consignments should be forwarded through a shipping agent and it would be desirable in the first instance to communicate with the broker or other firm selected, in order that proper arrangements for shipping might be made.

I am &c.,

ERNEST GOULDING,
for the Director.

The bulk of the world's supplies of dried ginger is at present produced within the Empire, in the West Indies, India, and West Africa. Jamaica ginger is of a relatively uniform high grade. Indian ginger is on the whole of somewhat lower quality, although certain kinds, such as Calicut ginger, realise prices approaching those of Jamaica ginger. The ginger produced in Sierra Leone, however, which forms a very large proportion of the material imported into the United Kingdom, is of a lower grade. The Imperial Institute is informed that the United Kingdom market could absorb increased supplies of ginger of the better qualities, and for this reason it has been considered desirable to draw the attention of present and potential producers to the best methods of cultivating the plant and preparing the product for the market. In the case of Sierra Leone and Dominica this has already been done to some extent by means of a memorandum sent recently by the Imperial Institute to the respective Governments of those countries. Through the agency of the present article, it is hoped to create an interest in the product in other parts of the Empire, where the conditions are suitable for its production.

THE GINGER PLANT.

The ginger of commerce consists of the underground stem or rhizome of a herbaceous perennial, *Zingiber officinale*, Roscoe, belonging to the natural order Zingiberaceæ, a section of the Scitamineæ. The rhizome is branched and bears at intervals upright leafy shoots, about 2 ft. high, and, usually distinct from these, an erect flowering shoot.

From very early times the plant has been grown from cuttings of the rhizome and, like certain other plants which are propagated entirely by vegetative means, such as the banana, fertile seed is rarely produced. The cultivated plant consequently shows little variation in botanical characters and the various forms of ginger which appear on the market owe their differences almost entirely to the method of cultivation and preparation practised in the region of production. It was at one time stated that the relatively juicy Canton ginger, from which the Chinese preserved ginger is prepared, was derived from a distinct though related plant, *Alpinia galanga*. This, however, is now known to be erroneous, and the succulence and slight pungency characteristic of Chinese ginger appear to be due to the special methods of cultivation adopted in China and to the rhizome being harvested at a comparatively early age (see p. 12).

The original home of the ginger plant is not known with certainty. It occurs wild in South-east Asia and in the Malay Archipelago, and it has also been recorded in a wild state in Columbia. It has been suggested, however, that the plants found in Colombia are relics of early cultivation, as may possibly be the case also in the other two regions mentioned.

CULTIVATION AND PREPARATION.

Climatic Requirements.

For the successful cultivation of ginger the essential requirements as regards climate are a good rainfall and a high temperature during the growing period. In the ginger-growing region of Jamaica the mean annual rainfall is 88 in., whilst in south-west India it is over 100 in. A dry season during the resting period and prior to planting is an advantage, as it facilitates the thorough preparation of the soil required for the crop, but is not essential.

Owing to the fact that a high temperature is needed for the optimum growth of the plant, cultivation is naturally most successful in tropical and sub-tropical regions. It need not be restricted to such areas however. Provided that the heat and sunshine are sufficient during the greater part of the year, a cold winter is immaterial, as before this period is reached the rhizomes will have been dug up from the ground, the bulk already prepared for the market and the remainder stored for planting the following season. These are actually the conditions obtaining round Canton and also in parts of Queensland where the crop is grown.

As regards altitude the plant succeeds in Jamaica from sea-level to considerable elevations, and in India also it is grown both in the low country and up to 4,000–5,000 ft. in the Himalayas.

Soil and Manure.

Ginger is an exhaustive crop and, unless manures are readily and cheaply available, the soil in which it is grown must be rich in plant food. The plant will not succeed in land liable to become water-logged or in soil of a gravelly or very sandy nature. The most suitable kind of soil, therefore, is a rich vegetable loam. The land must be well drained, as if water collects about the rhizome the latter is liable to rot.

The best varieties of Jamaica ginger are grown on a sandy loam, and in India the ginger produced on the compact black soils is said to be inferior to that grown on the lighter sandy loams. The amount of sand should probably be not more than 30 per cent., and of clay not above 20 per cent.

In Jamaica the primitive plan of clearing forest lands by fire was largely followed, and on this cleared land ginger was grown until the soil became exhausted, when it was abandoned and a new piece of land put into cultivation. This wasteful method resulted in the production of large tracts of exhausted land, which could only be brought under cultivation once more after considerable expenditure on chemical manures. In order to avoid this objectionable way of using land, experiments were carried out by the Jamaica Agricultural Society with a view to ascertaining the most suitable manures for ginger. A mixture composed of marl, with 10 per cent. each of soluble phosphates, ammonia, and potash salts, applied at the rate of one ton per acre, gave the best results. On worn-out land a yield equivalent to 2,960 lb of ginger per acre was obtained with this manure, whilst on the unmanured, exhausted land the plants hardly grew, and gave no return.

In most parts of India manuring is regularly practised, the manures generally employed being oil-cake and dung. In some parts old and well-decayed cow-dung is either applied at the time of the first ploughing or is put in the holes made when planting the crop. During growth the ground is sometimes top-dressed with mustard-cake and castor-cake, whilst the mulch of leaves, &c., often applied to the ground after planting, also serves to enrich the soil.

The principal constituents removed from the soil by ginger are stated to be lime and phosphoric acid, and it is the replacement of these constituents which should be aimed at.

Cultivation.

In Jamaica two methods of cultivation are adopted. That by which the best ginger is obtained consists in planting in March or April portions of selected rhizomes from the previous year's crop, care being taken that each portion planted contains an "eye" (embryo stem). The land is raised into ridges and the pieces of rhizome are placed a few inches below the surface and about one foot apart, the process being much the same as that observed in planting potatoes. It is advisable thoroughly to clear the land of weeds before planting the rhizomes, as the removal of weeds become difficult later on when the ginger plants have developed. Unless the rainfall is good it is necessary to resort to irrigation, as the plants require a good supply of water. The ginger produced in the foregoing way is known as "plant ginger."

"Ratoon ginger" is obtained by leaving in the soil from year to year a portion of a rhizome containing an "eye." This "eye" develops in the normal way, giving rise to a supply of rhizomes in the succeeding season. "Ratoon ginger" is smaller and contains more fibre than "plant ginger," and the product obtained by this means is said to deteriorate steadily from year to year.

In some parts of India it is usual to plant the crop in beds about 10 to 12 ft. long and 3 or 4 ft. wide, in which the sets are placed about 9 in. to 1 ft. apart. The field is then covered over with the leaves of trees or other green manure to keep the soil moist, and over the leaves organic manure is spread to a depth of about ½ in. At the end of the rainy season it is necessary to resort to irrigation. During the first three months of the dry season the field is weeded about three times.

Before planting, the land must be thoroughly hoed (or ploughed) and harrowed, in order to produce a fine tilth. In planting large fields it would appear preferable to open up drills about 4 in. deep and 2 ft. apart, much as is done in planting potatoes on a large scale. Artificial manure, such as superphosphate and bone meal, can then be incorporated in the soil at the bottom of the drill, before planting the sets.

On account of the crop taking up such large quantities of plant food a system of rotation should be adopted if possible. This is done in some parts of Jamaica, where much of the ginger is grown in small quantities as a garden plant, in association with bananas, chillies, &c.

The method of growing ginger in the Canton district of China differs considerably from that practised in countries where dried ginger is the objective. Low-lying ground is usually selected for the crop and the cuttings are set at intervals of 6 in. in ridges about 1 ft. high and 2 ft. apart. Water is kept continously between the ridges. After the shoots have reached a height of from 6 in. to 1 ft. the plants are heavily manured at frequent intervals with urine or nightsoil mixed with water. This favours the formation of the succulent rhizome characteristic of Chinese ginger.

"Ratoon ginger" matures early, and in Jamaica is harvested from March to December; but "plant ginger" is not ready for digging until December or January, the rhizomes being gathered as they mature from that time until March. The rhizomes are known to be ready for digging when the stalks wither, this taking place shortly after the disappearance of the flowers. In Jamaica the plant flowers during September. The rhizomes are twisted

out of the ground with a fork or a hoe. In performing this operation great care is necessary, as any injury inflicted on the rhizome depreciates its market value. Considerable experience is necessary in order to lift ginger rhizomes properly.

The " hands " (complete rhizomes and adherent fibrous roots) are piled in heaps, the fibrous roots are broken off, and the soil and dirt removed immediately, as otherwise it is difficult to get the finished ginger white. The rhizomes should not be allowed to lie long in heaps, as they are liable to ferment. The usual plan is, as soon as the rootlets and excess of soil have been removed, to throw the ginger into water to be ready for " peeling " or " scraping." This is done in Jamaica by means of a special knife, consisting merely of a narrow straight blade riveted to a wooden handle; in India the outer skin is scraped off with a shell or piece of broken earthenware. In the case of Sierra Leone ginger of the ordinary grade the flat sides of the hands are scraped with a spoon and the hands are then laid out to dry without washing in water.

The operation of peeling, if carried out in a proper manner, is a very delicate one, the object being to remove the skin without destroying the cells immediately below it, since these cells contain much of the oil upon which the aroma of the best qualities of ginger depends. As the rhizomes are peeled they are thrown into water and washed; and the more carefully the washing is done the whiter will be the resulting product. As a rule the peeled " hands " are allowed to remain in water overnight. Some planters in Jamaica add a small proportion of limejuice to the wash water at this stage, at the rate of about half a pint to six or seven gallons of water, in order to produce a whiter root.

After washing, the peeled rhizomes are placed in a " barbecue," which consists merely of a piece of levelled ground covered with cement, on which the ginger is placed to dry in the sun. Where a " barbecue " is not available, a " mat," consisting of sticks driven into the ground, across which are laid boards or palm or banana leaves, is used, on which the ginger is exposed until it is dry. Uniform drying of the rhizomes is essential for the production of first-class ginger and to prevent mildew; and to ensure this they should be separately turned over by hand at least once on the first day. Careful planters put their ginger out daily at sunrise, and take it in each night at sundown; conducted in the latter way the operation of drying usually takes from six to eight days. The ginger, if not sufficiently white in appearance, has to be bleached by further washing, and after being re-dried is ready to be packed for export. In some parts of India the peeled rhizomes are bleached by soaking in lime-water for a short time and exposing them for about 12 hours after drying to the fumes of burning sulphur in a specially constructed bleaching-room, at the rate of 7 lb of sulphur per ton of rhizomes.

The finished ginger is graded according to size and colour of the " hands " —the best grades consisting of the large plump " hands " free from traces of mildew, and the poorest shrivelled, dark-coloured " hands." As a rule the crop is divided into four or five grades. The best " hands " obtained in Jamaica weigh as much as 8 oz., 4 oz. being an average weight.

Unpeeled ginger is merely freed from its rootlets and excess of soil, and then thoroughly washed in water or scalded in a boiler of hot water, and finally dried in the sun

Preparation of Preserved Ginger.—In China the first crop of ginger is ready about three months after planting. This is known as " young ginger " and is the least pungent and most expensive. Unlike the Jamaica and

Indian ginger, the rhizomes are not allowed to mature, as they become too pungent for the purpose for which they are required. After harvesting the roots are washed and the skin carefully scrapped off. They are then punctured by means of a fork and afterwards washed in rice water (the water left after washing rice) to improve the colour. The rhizomes are next boiled in three or four changes of refined sugar and water for one or two hours, until thoroughly soaked. They are then placed in barrels or other containers and covered with syrup. In the case of dry preserved ginger, the wet rhizomes are strained till dry and then rolled in sugar placed on bamboo matting.

Yield.

The yield of ginger varies considerably with the climate, soil, and methods of cultivation employed. In Jamaica the average return is from 1,000 to 1,500 lb of dried ginger per acre, but as much as 2,000 lb per acre has been obtained under the best conditions. The recorded yields in different parts of India vary within wide limits. In Bengal it is stated that 1,000 to 1,5000 lb per acre is the average crop, in the Punjab 2,100 lb, in Travancore 2,000 to 2,500 lb, whilst in an experimental cultivation at Surat, Bombay Presidency, the yield was equivalent to over 8,000 lb per acre. As already mentioned, a yield equivalent to nearly 3,000 lb per acre was obtained in Jamaica on exhausted land by the application of a suitable manure; and there is no doubt that, by careful cultivation and manuring, the yield in all the countries mentioned could be considerably increased. It takes about 4 tons of fresh dug rhizomes to give 1 ton of dried ginger.

Pests and Diseases.

Owing to the pungent nature of the shoots, the ginger plant is attacked by very few insect pests, and it has even been recommended that the crop should be planted in orchards to prevent the development of pests of fruit trees. At the Rangpur Agricultural Station, Bengal, however, the larva of a Drosophelid fly, which lives on coarse grasses, has been observed to do a good deal of harm to the shoots.

In Southern India the caterpillar of a butterfly, *Udaspes folus*, sometimes does great damage to the leaves, whilst the caterpillar of a moth, *Dicchocrocis punctiferalis*, bores into the stem and rhizome, but seldom does serious harm. The latter is better known as a pest of castor plant in Southern India. In Travancore the rhizome is bored by the larva of a small fly (*calabota* sp.) which deposits its eggs at the base of the plants; when the crop is gathered the larva migrates to wild arrowroot, where it completes its development. The best remedy is stated to be the destruction of the alternative food plant.

The coconut scale, *Aspidiotus destructor*, has been found to occur on ginger in Fiji, but no information appears to be on record as to the extent of the damage caused.

Considerable injury is inflicted on ginger crops in Jamaica by a disease called "black rot," which attacks the underground parts of the plant, and brings about decay of the rhizomes. The first indication of the disease is a yellowing of the leaves, which droop and wither; the bases of the stems become discoloured and rot, and finally decay spreads to the rhizomes, which disintegrate to form a putrefying mass of tissue. A fungus present in the decomposing rhizomes was found to form spores in a similar manner to *Allantospora radicicola*, Wakker, a fungus which causes a root disease of sugar-cane in Java. It was not clearly shown, however, that the fungus found in the old rhizome was the cause of the disease (Howard, *Bull, Bot. Dept., Jamaica*, 1901, 8. 181; 1902, 9, 42).

A similar rot of the rhizome, caused by a species of Pythium, which occurs in India, was first recorded by Butler from Surat and is described by McRae in *Agri. Journ., India* (1911, 6, 139). The disease spreads rapidly through the soil, and to prevent infection of healthy plants every portion of an affected plant must be removed and burnt, whilst the soil itself should be treated with lime, or a light dressing of sulphate of iron may be applied. Isolation of infested soil by a trench has been tried with success, but in the case of a bad attack ginger should not be grown on the land for at least three years. The disease is most serious on wet, heavy soils or in exceptionally rainy seasons, and it may be prevented to a large extent by draining the land, so that no water lies round the collar of the plant. Great care should be exercised in selecting only healthy rhizomes for planting purposes, any plants with even the slightest trace of disease being rejected. After a bad attack it is advisable to steep the rhizomes for about half an hour in Bordeaux mixture before planting, to destroy any fungus spores or hyphæ on their surface or in the soil clinging to them. The fungus, which also occurs on tobacco and papaya in India, was at first thought to be *Pythium gracile*, Schenk, which in Europe is found on freshwater algæ. Subramaniam, however, showed that it is a distinct species, which he calls *Pythium Butleri* (*Mem. Dept. Agri., India, Bot. Ser.*, 1919, **10**, 181).

Another disease of ginger which does some damage in Jamaica is locally called " cork rot.' This cannot be detected until the crop is gathered, when the rhizomes are found to be of cork-like texture and quite valueless. The exact nature of this disease does not appear to have been investigated.

A new disease of ginger, caused by *Vermicularia Zingiberæ* and reported from the Godaveri District, is described by Sundararaman in *Mem. Agri. Journ., India, Bot. Ser.* (1922, 11, 209). The disease begins with small yellowish spots and later the whole leaf turns yellow and rots, resulting in a poor development of the rhizome. It makes rapid progress during a period of continued wet weather and high humidity, but the advent of drier conditions checks its growth and the plant may recover. Spraying with Bordeaux mixture was found to be effective against the disease.

USES OF GINGER.

For flavouring purposes ginger is perhaps the most widely used of all spices. It is employed whole in the preparation of various confections, chutneys, pickles and the like, and in the ground condition for a great variety of purposes. Large quantities are used in the manufacture of ginger beer, ginger ale and similar beverages. Its medicinal value is well known, the root being used chiefly as a stomachic and internal stimulant, especially in flatulency and colic. The pungency of ginger is due to the presence of a resinous substance and the odour to an essential oil. The latter is separated by steam distillation and used to some extent in perfumery. The characters of the oil are dealt with in this *Bulletin* (pp. 651,654) in connection with reports on a sample of ginger peelings from Sierra Leone and on a sample of the oil received from Seychelles.

In connection with the attempts being made to improve the quality of Sierra Leone ginger, the Imperial Institute recently made inquiries regarding the uses of the various types of ginger, the results of which may be here summarised.

Unscraped (unpeeled) ginger is used as a cheap substitute for peeled ginger for most of the purposes for which the latter is usually employed. When peeled ginger is relatively cheap less unscraped ginger is used in this way whilst, on the other hand, more of it is used when peeled ginger con-

mands a high price. A certain amount of unscraped ginger is also employed by distillers in the United Kingdom, who prefer it to peeled or scraped ginger, because it contains rather more essential oil. In the latter connection it was considered that the peelings might also find a market amongst distillers, and a sample was obtained from Sierra Leone for investigation at the Imperial Institute, the results of which are given on page 650 of this *Bulletin*.

For certain purposes only peeled ginger is suitable, *e.g.* for the "whole ginger" sold by grocers, for the best grades of ground ginger and for the best kinds of ginger beer. Unscraped ginger is sometimes used for the lower qualities of ground ginger, but not commonly for ginger beer. For medicinal use, "scraped" ginger alone is official in the British Pharmacopœia, but both peeled and unpeeled may be used for official preparations in the United States.

Ginger from no one country is in demand exclusively for any particular purpose. The peeled ginger from Jamaica, Cochin and Japan is all used for the same purposes, the grade of ginger employed depending on the quality of the article to be produced. Unscraped varieties from different sources are generally interchangeable.

From *Bulletin of the Imperial Institute*, 1926.

CULTIVATION OF PINEAPPLES.*

By D. H. GRIST, Agricultural Economist.

HAWAII and Malaya are the world's main centres for the production and canning of pineapples. The estimated area in bearing in Hawaii is 50,000 acres; while Malaya has a total of about 50,000 acres, 42,000 acres of which are situated in the State of Johore, and 8,000 acres on Singapore Island. Pineapple canning is also carried on to a lesser extent in South Africa (centred at Port Elizabeth), in Formosa and in parts of Australia.

The following account is a comparison of the systems of cultivation and the conditions obtaining in Malaya, Hawaii and South Africa.

Climate.

The climatic conditions in these three countries of production vary considerably. The following table shows the average rainfall and temperature.

Country.	Average rainfall. inches.	Average mean shade temperature.
Malaya (Johore)	89·09	80·0 F.
Hawaii (Honolulu)	31·60	74·6
South Africa (Port Elizabeth)	22·51	63·6

In Hawaii, the precipitation is heavier from November to March inclusive, but in South Africa the rainfall is fairly evenly distributed throughout the year. The rainfall in Johore is somewhat erratic; the rainy months are generally December to March, but there is usually an ample rainfall each month.

* The following account is compiled from information obtained over a number of years by officers of the Department of Agriculture S.S. & F.M.S. regarding Malayan pineapple cultivation; *Notes on the Pineapple Industry in Hawaii* supplied to the Director of Agriculture from a private source; and *The Pineapple Industry in South Africa* from a report by Mr. C. A. O'Conner of the Mauritius Department of Agriculture. Reference has been made to *Notes in Pineapple Cultivation* appearing in *The Tropical Agriculturist*, Vol. LXX, No. 1, January, 1928, and to *Growing and Canning Pineapple in the Hawaiian Islands*, in *Dun's International Review*, April, 1928.

The above figures demonstrate that pineapples will flourish within wide ranges of climate in the tropics or sub-tropics, but the system of cultivation must vary between these countries to adapt the crop to local climatic conditions.

SOILS.

Pineapples will grow on a wide range of soils, but favour the heavier types of soil with good soil aeration and drainage. The soils of Hawaii are of volcanic origin and rich in mineral plant foods. In Malaya, the crop thrives best on the stiff clay types of soil. A rich soil is held to be unsuitable as it tends to develop the size of fruit at the expense of flavour. It is for this reason that the fruit produced on the poorest of the Singapore lands have the best flavour when canned. It is probable that with a rich soil, growth is more rapid in Malaya than in either Hawaii or South Africa with their lower rainfall and temperature.

VARIETIES.

The two main varieties used in canning are the "Smooth Cayenne," a large pineapple with small "eyes," weighing about 5 to 6 lb and the "Queen" type, a smaller pineapple, with deeper and rather irregular eyes weighing about 3 to 5 lb. Opinions differ regarding the relative merits of these two varieties for canning purposes. It is held in Hawaii and South Africa—which have adopted the "Smooth Cayenne"—that the flavour of that variety is superior to that of the "Queen" types. In Malaya, the latter variety is used exclusively for canning as it is held to have a better flavour and to be more suitable for canning. Here again, it is possible that climatic and soil condition may be responsible for these differences of opinion, which, of course, are based on the experiences of the canners. The "Queen" type has two advantages of some importance—it is hardier, and it produces a greater number of "suckers" than does the "Smooth Cayenne," a matter of some importance in replacing or extending areas under the crop.

PRELIMINARY CULTIVATION.

The fundamental differences in system of cultivation between these three countries is that whereas in Hawaii and South Africa pineapples are treated as a sole crop, in Malaya they are almost invariably planted as a catch crop; generally in conjunction with Para rubber as the permanent crop.

In each case, it is realised that pineapples cannot be grown indefinitely on the same land: the land must either be rested after a number of years or it must be utilised for alternative crops after carrying pineapples for some years. The Hawaiian rich soils vary considerably; in some cases they produce fruit for three or four years, after which resting for one or more years is necessary; in other instances they are still bearing well after fifteen years. It is reported that many of the soils, however, are finished for pines after eight years. In Malaya, virgin soil is generally used for pineapple cultivation. The pineapples are planted directly the heavy jungle is felled, burnt and cleared. The plants commence to fruit in from 12 to 18 months, and will continue to fruit until the fifth to sixth year, by which time the fruits produced are small. The rubber which forms the main crop has also become a tree of considerable size, so that further cultivation of pineapples is out of the question.

Much of the Hawaiian pineapple land was formerly pasture land, but newer areas, in many cases, had to be cleared of cactus and rocks. It was never jungle and the islands are not thickly wooded. Abandoned land reverts to pasturage.

The South Africa pineapple land has to be cleared of bushes and grass.

Both in South Africa and Hawaii, the preliminary cleaning of the land is followed by a thorough cultivation of the soil. In the latter country, 95 per cent. of the land is cultivated with caterpillar tractors, steam ploughing equipment never being employed. As mentioned previously, in Malaya the land receives no cultivation before planting the pineapple plants.

PLANTING.

Pineapple planting material is of four descriptions: viz., ratoons, which are formed from buds on the stem among the roots; "suckers," formed in the leaf axils; slips, formed from buds appearing immediately below the fruit; and crown slips and crowns, formed from buds beneath and around the crown of the fruit. Ratoons and suckers are the most suitable for planting purposes, as they produce fruit earlier than do the less strongly developed slips, which are very small and should first be planted in a nursery to develop a strong root system. The effect of planting material and climate may be seen from the following comparison of the length of time taken for the plants to reach the bearing stages:—

Country.	*Crowns.*	*Suckers.*
Malaya	18 months	12 months
Hawaii	20 months	14—16 months
South Africa	2 to 2½ years.	

Considerable variation exists with planting distances employed in different countries. The usual Malayan system is to space the plants 5 ft. by 2½ ft., with a six foot path at every 100 feet. This spacing gives from 3,000 to 3,400 plants per acre. In Hawaii, it is customary to plant very close, 9,000 to 12,000 plants per acre, with a tendency towards an even denser population of plants. Slips or suckers are usually planted in double rows, 12 to 18 inches between plants in the row, 16 to 24 inches between rows. The distance between the centre of this double row and the centre of the next double row is about 6½ feet.

The South African practice is to plant in double rows, the plants being two feet in the row and two feet apart between rows; a space of five feet is left between the double rows. In this system there result about 6,300 plants per acre.

Suckers and ratoons for planting are cut square at the base, the lower leaves removed and frequently dried in the sun for a while before being planted. In some quarters it is held that there is no advantage in the preliminary drying, but it appears to be the usual practice both in Malaya and Hawaii.

The plants should be placed from three to four inches deep in the ground—the actual depth depending upon the size of the plant. Care must be taken that no soil or sand enters the bud as it will kill the plant, or at least retard its development.

CULTIVATION.

After planting, the fields require weeding, but apart from such attention no further cultivation is given in Malaya. In the other countries of production, however, the low rainfall renders it necessary to do everything possible to conserve the moisture in the soil. The usual method of frequent surface cultivation achieves this object, but in Hawaii, exceptional measures are taken, partly at least towards this end. The fields are mulched, with an asphalt-treated paper so spread as to provide spaces necessary for cultivation and harvesting. It is claimed that this mulch (under the commercial name of "Pabco") reduces weeding costs, conserves heat and moisture;

and so increase yields as to render it a financial success. The " Pabco " is first spread—sometimes by a machine which lays it flat, turns down the edges and kicks up earth to keep it down—and the plants placed in holes made in it with a trowel. The disadvantage mentioned against the " Pabco" mulch is that it forms a breeding ground for pests. This mulch is widely used in Hawaii. Owing to the heavy rainfall, it would not have the same advantages in Malaya. Pineapple land is ploughed four or five times a year on African plantations, the ploughing being done with oxen.

Mention must here be made of a peculiar feature in pineapple planting in Malaya. The great majority of the areas under this crop are owned by Chinese, who, in many cases, are the owners of the factories. The Chinese owner of land which he wishes developed with pineapples and rubber makes an arrangement with a number of Chinese squatters to plant up his land with pineapples and to keep it clean for an agreed charge per month per acre. Each squatter is thus definitely and absolutely responsible for a portion of the estate, and generally erects his own temporary abode thereon. The agreement provides that a squatter shall get 50 per cent. of the value of the pineapples as a bonus, after cartage costs have been deducted and the agreement usually contains a clause which provides for the payment to the squatter of a certain sum per acre for cleaning the pines off the land after five years. In one typical instance, the agreement provided for the payment to the squatter of $1 an acre a month to cover the full cost of planting and weeding, a bonus of 50 per cent. of the value of pineapples after deduction of cartage costs, and the payment by the owner of $8 per acre for cleaning off land and burning the pineapple plants at the completion of the agreement.

Such complicated methods of management are possible between Chinese and Chinese, but are impossible between European and Chinese.

The usual Malayan contract rates are around $7 per acre for planting; and for weeding and earthing up plants, $2.50 per acre per mensem.

In Hawaii, the land is manured just before planting, and a further application is sometimes given before the plants commence to bear fruit.

It is difficult to obtain data of the labour requirements for cultivation, but some idea of the probable cost can be obtained from the requirements of an Hawaiian plantation. An estate of three or four thousand acres is run by one man. Under him are Japanese conductors, one for every 1,000 acres. They will have under them ten heads of coolie gangs, each of which would be in charge of about ten coolies at the height of the season. Salaries: Manager, about $1,000 per month; Divisional Manager, $550; Conductor, $90; all sharing in profits.

The permanent labour force is about 60 men per 1,000 acres, a number which is in excess of requirements in the slack season. This number may be increased to over 100 men per 1,000 acres during the busy season. Formerly, the labour force was mainly Japanese, but owing to restriction on Japanese immigration, they have now been largely replaced by Filippinos.

YIELDS.

In Malaya, there are two main crops per annum, the first in May and June and the second in November and December, but the plantations are producing fruit throughout the year. During the first year of fruiting the plant will produce one fruit, but in subsequent years, two fruits per plant are usually obtained. The average annual yield is between 4,000 and 5,000 fruits per acre per annum.

Although there is fruit being obtained throughout the year, the main Hawaiian harvest, June to August produces the heaviest crops, with a second

crop in December to February. When the first crop is obtained—one fruit per plant—all suckers, with the exception of two, are removed; as a rule, no further removal of ratoon are made unless they are required for planting purposes. The Hawaiian plantations, by reason of close planting, the application of manures and cultivation, produce heavier crops than are obtained in Malaya. In South Africa, the annual crop is estimated at between 6,000 and 10,000 fruits. Although the yields of pineapples from Malaya are small, it must be remembered that the capital invested is also smaller than with other countries, and that the land is planted with a second crop—rubber.

An estimate of the cost of bringing an acre of pineapples into bearing in Hawaii has been stated as follows (currency, dollars gold).

Clearing, $40; ploughing, $25; plants, $56; planting, $10; weeding and ploughing, $27; fertilising, $35; harvesting, $13.50; collecting, $36; total, $242.50.

It must be understood that subsequent crops will cost very much less; the only fair way of arriving at cost being to average it over a period of not less than four years.

In a subsequent number of *The Malayan Agricultural Journal* it is proposed to conclude this series of articles on pineapples by a consideration of the subject of pineapple canning.

PIGS AND PIG PRODUCTS.

TWELFTH REPORT OF IMPERIAL ECONOMIC COMMITTEE.

RECENTLY published by the Imperial Economic Committee is a very interesting and valuable report entitled *Pigs and Pig Products*. The report deals with the marketing and preparation for market of pigs and pig products within the Empire and in those countries from which pig products are imported into Great Britain.

2. Much of the report, particularly that dealing with manufactured products and markets overseas, is of no economic interest to pig raisers in Fiji in the present state of our development and will not be considered in this review which will be confined to those parts dealing with such features of the industry as breeds and types, feeding, housing, association with dairying, grading, &c.

3. The following is a brief resumé of the points raised in which Fiji may be interested:—

Breeds.—White breeds are not popular in most tropical countries. These breeds are, however, very popular amongst the importing countries. Other popular breeds in the Empire are Berkshire, Tamworth, Gloucester Old Spot and others. The report, h wever, is unfavourable to a multiplicity of breeds, as such a condition is not conducive to the production of a uniform type so desired by the manufacturers and pork butchers.

Feeding.—The report emphasises the importance of an abundance of cheap food in pig raising areas. The areas raising the greatest proportion of pigs are those in which the chief products are maize, potatoes and dairy products. In U.S.A. five states, forming the centre of the maize belt produce two-fifths of the total number of pigs in that country. Other important foods are barley and other hard grains. The type of pig produced varies with the

food materials. Those fed chiefly upon potatoes or maize are of the very fat type, whilst those whose ration consists of milk products and hard grain are of the lean, very firm type.

Housing.—This question is not dealt with at much length by the report, but nevertheless is a subject of great importance. Housing requirements will vary depending on the climatic conditions.

Association of pig-breeding industry with dairying.—The necessity of establishing the pig-raising industry in connection with dairying is emphatically stressed. It is pointed out that the raising of pigs on the by-products of dairying is the most profitable method of disposing of such products. Denmark's example in this respect is pointed out, and attention is drawn to the suitability of New Zealand for pig-raising on account of its extensive dairying industry.

Marketing.—The keystone of this discussion is the necessity of co-operation among all persons interested in the pig-raising industry. First and foremost the consumers' needs must be satisfied, and to accomplish this, understanding must exist between breeders, agents, butchers and other people concerned in the trade. Each breeder should endeavour to maintain a regular supply, and organisation should exist amongst breeders to prevent over-production and to ensure a regular supply.

Pig-raising on closer settlement areas.—The report raises the point that pig-keeping plays or should play an important part in closer settlement. In Denmark one-third of the pigs are raised on farms of less than 37 acres and seven-eighths on farms of less than 150 acres.

THE PIG AND PIG PRODUCTS REPORT AS IT APPLIES TO FIJI.

By H. M. STUCHBERY, B.V.Sc.

Elsewhere in this *Journal* will be found a review of the report on pigs and pig products by the Imperial Economic Committee. This report contains much that is of interest to those associated with the industry in Fiji, and much valuable information may be gleaned from its pages.

2. The question of breeds is interesting. It will be noted that the white breeds are not popular in other tropical countries, but it cannot be said that these breeds do not thrive in Fiji provided they receive reasonable treatment. Certainly those kept in sties or having access to suitable shelter do quite well. Possibly, were they allowed to run at large without shelter from the tropical sun's rays they would not do as well as the other breeds, but this state of affairs is not usual in Fiji where abundance of shade is usually to be found. The coloured breeds such as the Berkshire and Tamworth do very well in Fiji.

3. Of the food sources mentioned in the report, the only ones common to Fiji are maize and dairy by-products. We have however, many foods here eminently suitable, such as rice-bran, coconut meal, bananas and various roots such as kumalas. Most of these could be produced very cheaply, much more so in fact than food-products used in other countries for pig-raising.

4. The question of pig-raising in association with dairying is an important one to Fiji. At present we are not making sufficient use of dairy by-products such as skim milk. By the feeding of these to pigs a much bigger revenue could be derived from dairy farms at little extra cost. In addition

to this, other good pig-foods could be obtained quite close to our dairying areas at a very reasonable cost. When the Tailevu road is completed all the dairying centres will be within easy reach of the main Suva market.

5. Suitable housing for pigs is most important in Fiji. The presence of parasites, particularly the kidney worm (*Stephanurus dentatus*), has to be considered, and methods of control adopted. Dirty and badly drained sties make ideal conditions for the spread of these parasites. On the other hand, these parasites spread with equal facility in damp low-lying, pastures or those with " wallow-holes " on them. Pig-sties should, therefore, be well drained, and capable of being cleaned and disinfected easily. As well as this, pastures should be dry and also be changed frequently.

6. Methods of marketing in Fiji, where there is only a local market to be supplied, will necessarily differ from those in other countries catering for both home and export markets. However, the principles of co-operation and understanding between each section concerned in the trade is just as important as is also the regular supply of pigs of a uniform type. At the present time, for the Suva market, the demand for pigs for slaughter is limited to about 80 animals a month. It would be necessary for breeders to keep their monthly supplies at this figure in order that there should be no over-production. There is, however, throughout the Colony, a considerable consumption of pig meat, whilst in the vicinity of Suva, a considerable amount is consumed by Chinese, Fijians and others, which is not included in these figures.

7. Profitable pig-raising appears to go hand in hand with closer settlement in agricultural and dairying communities. It is a fairly regular practice in other parts of the Empire, for the majority of farmers on closer settlement areas to indulge in pig-breeding to a greater or less extent. In Fiji we have many such areas eminently suitable for pig-breeding. The chief drawbacks at present are a lack of market for the animals if the industry was developed extensively, and the lack of knowledge on the part of settlers, of the principles of pig-breeding. It is probable, however, that the demand for pork and bacon will increase as time goes on and supplies will have to be increased.

8. There is an art in pig-raising and some skill is required. All farmers will not be successful but there would appear to be no reason why the industry should not be immediately developed by those adapted for it to meet at least our local requirements.

THE SECOND IMPERIAL MYCOLOGICAL CONFERENCE.

Report by J. G. C. CAMPBELL, B.Sc., Government Mycologist.

I HAVE the honour to submit the following report on my attendance, as representative of Fiji, at the Second Imperial Mycological Conference, held held in London 23rd to 28th September, 1929.

2. On 16th September I received a letter from the Colonial Office informing me that it was the wish of the Secretary of State that I should comply with the desire of the Acting Governor of Fiji and attend the Conference as representative of the Fiji Government.

3. The Official Report (Colonial No. 45) gives a very full summary of the proceedings of the Conference so that, in my own Report, I have considered it necessary only to collect together and comment on those sections which, I think, are of direct interest to Fiji.

4. Most of the contributors to the discussions dealt with the diseases of temperate crops; on the whole, tropical crops, and especially those of interest to Fiji, received only passing mention.

5. A great part of the time was devoted to the consideration of the administrative side of Plant Protection Services. I have attempted to summarise the opinions which were put forward by various speakers and accepted by the Conference.

6. The basic assumption is that every country, and particularly every tropical country is entitled to take whatever measures it considers necessary for the protection of its crops.

7. The object of regulations shall be to control the movement of plant material into the country so that the possibility of introducing disease or pest is reduced to a minimum. In formulating such regulations consideration must be given to the economic effects of their introduction, *e.g.*, restriction of food plants would be impracticable. Consideration should also be shown to exporting countries which the regulations will effect and, in some cases, it might be advisable to obtain the views of particular exporters in those countries. The result might be the avoidance of unpleasantness and inconvenience by the imposition of unnecessarily strict restrictions.

8. A necessary preliminary to the formulation of regulations to protect any crop is a thorough knowledge of the habits of causal organism and a knowledge of the geographical distribution of the diseases.

The Conference expressed its appreciation of this fact in Resolution No. 6*. It was suggested that the Imperial Bureau of Mycology should issue lists or maps indicating the distribution of the more serious diseases of imported crops.

9. In order to keep the knowledge of disease distribution up to date, it was considered essential that each country should publish a list of the diseases with which they were afflicted and should promptly notify any change in the general plant disease situation or the appearance of any new disease.

It was suggested that some scheme of co-operation might be arranged on the following lines:—

(*a*) *Group notification.*—Countries geographically situated so that the transference of disease from one country to another was a potential danger should notify one another directly of any change in the plant disease situation.

These countries might also come to some agreement among themselves as to the treatment of any plant materials exchanged between them (Resolution No. 8).*

(*b*) All countries should notify any change in the plant disease situation to the Imperial Bureau of Mycology which would publish the information in the *Review of Applied Mycology* for general information, or, if necessary, inform interested countries directly.

(*c*) All new regulations, alterations or amendments should be promptly notified to group countries and to the Bureau of Mycology for general information.

For the information of Delegates attending the Conference, the Bureau of Mycology drew up a summary of the plant protection regulations in the Dominions and Colonies. This interesting document* is attached to this report.

10. Regulations to restrict the importation of diseased material should be based on the following principles:—

* Not printed.

(*a*) The importation of plants susceptible to the disease against which the regulations are directed may be prohibited either entirely, or from certain countries. Alternatively, they may be imported only with the permission of the agricultural authority who will decide in each case whether importation may safely be permitted, and under what conditions.

A number of delegates considered that total prohibition was the only safe method. It was generally agreed that the success of total prohibition would depend on the geographical situation of the country, the efficiency of the plant protection service and in general, the effectiveness with which the illegal importation of plants could be controlled.

(*b*) The plant material should be restricted to that necessary for propagation, should be imported only with the consent of the agricultural authority and should be retained under strict official quarantine untill such time that it can be definitely decided that it is not affected with any disease.

This is the method which should be observed for the introduction of new stocks of a staple crop. Its success depends on the rigid observance of quarantine.

After discussion on this matter, the Conference passed Resolution No. 3.*

(*c*) Plant material may be admitted after being treated in some approved manner to render it inocuous. It was generally considered that, as far as fungal diseases and especially diseases due to filtrable viruses were concerned, this method would be most unreliable. Under certain conditions, it might be workable, but as a general principle, it was bad.

(*d*) The fact that a disease is already present in the country is not necessarily a justification for permitting the unrestricted entry of material infected with the same disease. The danger to be guarded against is the introduction of a new biological strain which might prove much more destructive than the strain already present. This has been exemplified particularly in the case of the rusts of cereals.

(*e*) Under certain conditions, the importation of infected material may be permitted if the disease concerned is not likely to endanger staple crops. This applies particularly to the importation of food plants. It should, however, be avoided if possible.

11. Much consideration was given to this matter of certificates to accompany imported and exported plant materials. This resulted in the adoption of Resolutions Nos. 7 and 7 (*a*).*

12. It was considered that a certificate should not be regarded merely as a guarantee of quality. It should be rather a document giving as much information as possible about the health of the consignment. A certificate should be given and accepted on this understanding.

13. It was unanimously agreed that it was a practical impossibility for the Mycologist, or any other officer, to certify, from inspection alone, that any particular consignment was free from disease.

14. It was considered that inspection of the crop in the field was of considerable importance in determining the freedom from disease of a consignment. It was considered essential where seed stock was concerned.

15. It was considered desirable that, if possible, some standard form of certificate should be adopted for use between countries of the British Empire. The certificate given in Appendix 1A of the Conference Report was adopted as a working basis, the intention being that it was to be circulated to the

* Not printed.

various Governments concerned for criticism. The following were the points emphasised:—

(*a*) The examination should be made as near as possible to the time of shipment, the exact time being noted on the certificate.

(*b*) A representative sample of the shipment should be examined.

(*c*) If possible the crop should have been examined in the field; this examination or its omission should be noted.

(*d*) The place where the crop was grown should be noted, this being considered to be of more importance than the place of export.

(*e*) A certificate of absolute freedom from disease is not required, but any disease or pest observed should be noted, whether specified in regulations or not. Where a special examination is made for any particular disease, this should be specifically noted.

(*f*) Any treatment to which the consignment has been submitted should be noted.

16. It was to be distinctly understood that the acceptance of this or any other certificate did not prevent the importing country from exercising its right to prohibit, quarantine, treat or otherwise deal with the consignment.

17. Regulation should be framed in such a way as to deal with any emergency that might arise, *e.g.*, the prevention of the entry of a diseased consignment should not be made impossible because the disease concerned is not included in some schedule.

18. A little discussion took place on the internal control of plant diseases. Delegates from tropical countries agreed that most of their difficulties arose out of ignorance, lack of interest and absence of co-operation on the part of the planters—in most cases, natives. The primitive methods of cultivation—or lack of any method—were also considered to contribute towards the difficulties encountered. It was agreed that education of the planters by means of travelling instructors was the best means of combatting disease and that police methods were, on the whole, quite useless.

19. It was concluded that it was not desirable, nor, in fact, practicable to formulate standard regulations for general adoption. Each country must make its own arrangements, giving due consideration to the principles previously outlined, but it was thought that co-operation between countries which exchange plant products was highly desirable for the harmonious working of their respective plant protection services.

20. Mention was made of the grading of plant products. It was suggested that some standardisation of grading was necessary and that consideration should be given to the disease carrying potentialities of produce especially in connection with seed stock.

21. Continuing with other subjects dealt with by the Conference, the diseases of fruit shipped Overseas formed the subject for discussion at one of the meetings. Although most of the references were to the troubles experienced in the shipment of apples to England, and the work of the Low Temperature Research Station, a few references were made to the transport of bananas. These are given, though it is not considered that they add to the knowledge which we already possess.

22. Mr. Smith of Jamaica outlined the method of shipping fruit from the West Indies. The only variety shipped to any extent was the Gross Michel. The entire shipping was done by the Fruit Company and not by individual growers; this greatly simplified matters. The fruit was carefully graded, the particular grade sent depending on the destination. Thus, the less

mature fruit would be sent to Europe and the United Kingdom, more mature to New York and so on. The grades, which are selected so that the fruit will be ripening on arrival at its destination are:—

(*a*) " bursting full," *i.e.*, almost ripe;
(*b*) " found full ";
(*c*) " Full three-quarter " in which the fruit is still ridged;
(*d*) " Three-quarter."

The fruit is shipped in bunches of 6, 7, 8 or 9 hands. The grading and general condition of the fruit is checked frequently until loaded. Bunches are packed so as to give the maximum amount of ventilation. After loading, the hold is immediately cooled, the temperature being reduced to 52–55 degrees Fahrenheit in 3–3½ days by circulating cold air. The result is that very little transport trouble occurs. *Gleosporium* ripe rot is sometimes seen and occasionally a stem end rot associated with *Thielaviopsis*.

Cavendish bananas, if shipped, must be very carefully packed because they are much more readily damaged than the Gros Michel. Trouble is sometimes experienced with a rot associated with *Gleosporium* and connected with the persistence of the style in this variety. The Red Banana is shipped in the same way as the Gros Michel. Other varieties are not shipped as they ripen too rapidly.

23. Dr. Reichert described the following diseases of Cavendish bananas in Palestine:—

(*a*) Tip End Rot caused by *Macrophoma musarum*;
(*b*) Cigar End Rot caused by *Fusarium sp.*;
(*c*) Steam End Rot, commencing at the stem end of the fruit, and associated with *Fusarium sp.* This condition appears to be identical with " Black End " of Fiji;
(*d*) Rots caused by *Botrytis* and *Sclerotium*;
(*e*) Rot of the entire fruit caused by a *Diplodia* and found only in fruit growing among organges which are frequently affected with *Diplodia*.

24. According to Mr. Tomkins of the Low Temperature Research Station, much loss was experienced from rot due to *Thielaviopsis* in pineapples from the Azores.

25. On the subject of the Control of Insect Pests by means of Entomogeneous Fungi, the speakers were agreed that there was very little hope of securing economic control of insects by this means.

26. A paper was read by Mr. Bunting on the Deterioration of Produce by Moulds. I was unfortunately unable to attend the Conference on this occasion, but Mr. Bunting informed me that it was the intention of the Stored Products Investigation Station with which he was associated, to investigate the problem of the deterioration of copra by moulds. Mr. Bunting expressed his willingness to consider Fijian copra in his investigations and it is my intention to visit the Station at Slough, before my return to Fiji, to see if it will be possible to arrange with him some co-operative scheme.

27. The last matter which I think is of interest to Fiji is that mentioned in Resolution No. 2* on the provision of handbooks on the diseases of tropical countries. There are no adequate books on tropical diseases as there are for the diseases of temperate climates. The proposal is to supply this deficiency by means of a series of books published under the general editor-

* Not printed.

ship of the Bureau of Mycology and compiled by specialists on the various diseases. The volumes which would be of particular interest to Fiji are those on Cotton, Coconuts, Bananas and other Fruits, Cereals and Rice and Ground Provisions (which covers native food-stuffs, &c.)

Should Fiji be approached as suggested in para. 8 of the Committee's report, I would recommend the project to the Government for favourable consideration.

28. In conclusion I have only to add that I voted affirmatively to all the resolutions submitted to and adopted by the Conference.

PRESERVATION OF TIMBER.

THE following notes have been forwarded by Dr. J. D. Tothill, Director of Agriculture, Uganda:—

Papers have appeared recently in the *Journal of Industrial and Engineering Chemistry* on the subject of a new wood preservative said to be superior to Creosote. The method consists in soaking the air-dry timber in a solution containing the following materials:—

	Per cent.
Sulphuric acid	0·30
Zinc sulphate	3·00
Calcium acetate	2·10
Caustic Soda	0·75
Arsenic	2·25

After soaking, the timber is air dried and is then ready for use.

The note discussing this method states that—

> "In January, 1928, the U.S. Department of Agriculture installed "a number of zinc meta-arsenite treated yellow pine posts on Barro "Colorado Island, Panama Canal. When officially inspected in Feb- "ruary, 1929, they were in perfect condition showing no decay and "*no attack by white ants*. Untreated yellow pine posts set at the same "time were completely destroyed. There are 36 species of tropical "termites on the island and the annual rainfall is about 130 inches."

SUBSIDIES FOR IMPORTATION OF LIVE STOCK.

IMPORTATION OF PEDIGREE AND GRADE CATTLE.

GOVERNMENT SUBSIDIES.

AT the meeting of the Legislative Council in May, 1930, approval was given for the increase of the subsidy on imported pedigree cattle and horses from £7 per head to £10 per head and of the payment of a subsidy of £5 per head on grade cattle of good quality. The rules governing the payment of subsidies are set out below:—

RULES REGARDING SUBSIDIES PAYABLE IN RESPECT OF IMPORTATION OF CERTAIN LIVE STOCK.

2.—(1) *Pedigree Cattle and Horses.*—A subsidy of £10 per head will be paid for each registered pedigree animal capable of breeding brought into the Colony. The subsidy will apply only to cattle which have attained the age of nine months and have not attained the age of five years and horses which have attained the age of nine months and have not attained the age

of eight years. An animal imported under the age of nine months, if otherwise qualified, shall be eligible for the subsidy on attaining the age of nine months.

Grade Cattle.—A subsidy of £5 per head will be paid for each female animal which has been registered, in the country from which it has been imported, as being the progeny of a registered pedigree sire and a dam which has been credited, by a Herd Testing Association, with having produced in one lactation period, the following amounts of butter fat (or over) according to age at the commencement of the test, viz.:—

as a 2 year old, 250 lb butter fat,
as a 3 year old, 275 lb butter fat,
as a 4 year old or older, 300 lb butter fat.

The subsidy will apply only to animals which have attained the age of nine months and have not attained the age of five years. An animal imported under the age of nine months, if otherwise qualified, shall be eligible for the subsidy on attaining the age of nine months.

(2) An animal must have been not less than one month in the Colony at the date of the application for the subsidy.

(3) Every importer of pedigree or grade animals, in respect of which it is intended to claim the subsidy, shall give one month's notice in writing to the Director of Agriculture of his intention to import, and shall state the number of animals to be imported.

(4) When applying for the subsidy, the importer will be required to state the country of origin and in the case of pedigree animals the particular herd or stud in which each animal is registered and to attach a certified copy of the pedigree or of the pedigree transfer certificate of each animal. In the case of grade animals the importer will be required to attach a certified copy of the heifer calf registration certificate.

(5) Before payment of the subsidy, each animal must have passed all quarantine regulations under the Animals Importation Ordinance 1886, and have been admitted to the Colony.

(6) The subsidy will not apply to animals which, in the opinion of the Government, have been imported for the purpose of sale. An importer who has been paid a subsidy or subsidies in respect of an animal or animals imported by him and who sells those animals within one year from the date of importation shall be liable to refund the whole or part of the subsidy.

(7) The total amount of subsidy payable to any importer in any calendar year shall not exceed £100.

(8) These Rules shall take effect from the first day of June, 1930.

FREIGHT RATES.

3. The freight rates on cattle imported from New Zealand by Union Steam Ship Company's steamer are as follows:—

Bulls	£8 10 6 each
Bulls (yearlings)	6 1 0 ,,
Cattle 1, 2 or 3 head	5 10 0 ,,
Cattle 4 head	5 4 6 ,,
Cattle 5 head	4 19 0 ,,
Cattle 6 head or more	4 13 6 ,,
Calves up to 9 months	One-third off cattle rates
Calves under 1 month	Free.

PRE-SHIPMENT CONDITIONS.

4. Cattle imported from New Zealand must be accompanied by—

(1) a statutory declaration by the shipper giving a description of the animals and certifying—

(*a*) that the animals have been free from disease during the six months preceding the date of shipment;

(*b*) that they have not been in contact with any diseased animals during the six months preceding shipment and giving the name of the district in which they have been during that time;

(*c*) that they have not, otherwise, than is required by (2) below, been tested with tuberculin during the two months preceding shipment;

(2) a tuberculin test certificate by a qualified Veterinarian endorsed by the Chief Veterinary Officer of the Department of Agriculture of the State concerned. The certificate shall state (*inter alia*) the date on which the test was applied;

(3) a certificate from a Government Veterinarian or Veterinarian employed in an official capacity by a local Government authority stating—

(*a*) that he has examined the animals within seven days of shipment and found them to be free from disease; and

(*b*) that they have been dipped or thoroughly sprayed within thirty-six hours of shipment with a standard arsenical anti-tick solution, the name of the preparation to be given;

(*c*) that the agglutination test for contagious abortion has been applied with negative results within fourteen days of the date fixed for shipment.

QUARANTINE.

5. Cattle imported from New Zealand are required to undergo a period of quarantine of seven days. The regulations provide that they shall be dipped whilst in quarantine.

NOTICE OF IMPORTATION.

6. They may be imported through the port of Suva only. *The importer is required to obtain, not less than one month prior to the date of arrival of the cattle, the written permission of the Superintendent of Agriculture to import.*

FEES AND OTHER CHARGES.

7. Inspection and other fees payable in the Colony are as follows:—

Wharfage	1/6 per head
Port and Customs Service Tax	1 per cent. of value
Inspection Fees—	
For one and not exceeding four head ..	£1 1/-
For every additional head over four and not exceeding fifty	2/-
For every additional head over fifty ..	1/-
Transport Fees—	
For each trip of the cattle punt from the ship to the Quarantine Station ..	10/-

Dipping Fees--

Cattle over six months old	5/- per head
Cattle six months and under	1/- per head

When six or more cattle are imported by any person at any one time, reductions will be made in the dipping charges as follows:--

Numbers.	*Reduction in Fees.*
From 6 to 10	10 per cent.
From 11 to 20	20 per cent.
From 21 to 50	33⅓ per cent.
Over 50	50 per cent.

Upkeep and Sustenance Charges whilst in Quarantine—

Cattle one to four (per head)	3/- per diem
Each animal above four (per head)	1/- per diem.

EXAMPLES:

8. The total charges connected with freight, wharfage, inspection, transport, dipping and sustenance would be, on the rates shown above (which are subject to alteration), as follows: (Port and Customs Service Tax is not included as it is not possible to calculate the charge without the value of the animals being known):—

One Adult Bull from New Zealand: *Subsidy on one pedigree bull on conditions already stated* £10

Freight	£8 10 6
Wharfage	0 1 6
Inspection Fee	1 1 0
Transport Fee (if no other stock on board for transport to the Quarantine Station)	0 10 0
Dipping Fees	0 5 0
Sustenance Charge, 7 days at 3/- per diem	1 1 0
	£11 9 0

One Yearling Bull from New Zealand: *Subsidy* £10

Freight	£6 1 0
Wharfage	0 1 6
Inspection Fee	1 1 0
Transport Fee	0 10 0
Dipping Fee	0 5 0
Sustenance Charge	1 1 0
	£8 19 6

Six Pedigree or Grade Cows or Heifers over 9 months of age—

Subsidy in respect of pedigree animals	£60
Subsidy in respect of grade animals	£30
Freight at £4 13s. 6d. each	£28 1 0
Wharfage	0 9 0
Inspection Fees	1 5 0
Transport Fees	0 10 0
Dipping Fees	1 7 0
Sustenance Charges	4 18 0
	£36 10 0

Twenty Pedigree or Grade Cows or Heifers over 9 months of age—

Subsidy in respect of pedigree animals (limit)				£100
Subsidy in respect of grade animals (limit)				£100
Freight at £4 13s. 6d. each	£93	10	0	
Wharfage	1	10	0	
Inspection Fees	2	13	0	
Transport Fees	0	10	0	
Dipping Fees	4	0	0	
Sustenance Charges	9	16	0	
	£111	19	0	

Twenty Pedigree or Grade Heifers under 9 months of age—

Subsidy pedigree animals (on attaining 9 months) (limit)				£100
Subsidy on grade animals (on attaining 9 months) (limit)				£100
Freight at £4 13s. 6d. less ⅓	£62	6	8	
Wharfage	1	10	0	
Inspection Fees	2	13	0	
Transport Fees	0	10	0	
Dipping Fees (over 6 months) (Six months or under the charge would be 16/-)	4	0	0	
Sustenance Charges	9	16	0	
	£80	15	8	

FIJI LIVE STOCK RECORD ASSOCIATION—MINUTES OF MEETING.

MEETING HELD ON 11TH JULY, 1930.

Present.—Director of Agriculture (Chairman), Senior Veterinary Officer, G. Kiss, Esq., and J. Barber, Esq.

Owing to an oversight R. Craig, Esq., was not advised of the meeting.

The minutes of the last meeting were read and confirmed.

The Chairman drew the attention of members to an article on livestock in Fiji prepared by the Senior Veterinary Officer for publication in the *International Register of Pedigree Stock Breeders*, and stated that a copy would be made available to members for perusal on application.

The Chairman stated the action taken by the Government towards assisting importers of pedigree and grade stock and stated that a memorandum on the subject would be distributed in due course.

The Board directed that an effort be made to exhibit a list of the members of the Association, particulars of animals registered, &c., in the Agricultural Department's exhibit at the Suva Show. The Secretary was instructed to take the necessary steps to carry out this instruction.

Mr. Kiss suggested that the Association should open a Calf Register and that animals registered therein should not be transferred to the main Register until after they had been inspected and passed as suitable for inclusion. The Board directed that this matter should be considered at a later meeting.

CONTENTS.